SOIL SURVEY OF

Thurston County, Nebraska

United States Department of Agriculture
Soil Conservation Service and
United States Department of the Interior
Bureau of Indian Affairs
In cooperation with
University of Nebraska
Conservation and Survey Division

Issued March 1972

Major fieldwork for this soil survey was done in the period 1957–64. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Bureau of Indian Affairs, in cooperation with the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Thurston Soil and Water Conservation District and to the Omaha and Winnebago Tribal Councils. Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for agriculture, industry, and recreation.

Locating Soils

All the soils of Thurston County are shown at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the windbreak suitability group and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and ranchers and those who work with farmers can learn about use and management of the soils from the soil descriptions, from the discussions of the range sites, and from the section "Woodland and Windbreaks."

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife and Recreation."

Ranchers and others interested in range can find, under "Management of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Thurston County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "General Nature of the County."

Cover: Farming on gently sloping and sloping Moody and Nora soils.

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SOIL SURVEY OF THURSTON COUNTY, NEBRASKA

BY NORMAN L. SLAMA, DEAN W. DaMOUDE, AND DONALD E. KERL, SOIL CONSERVATION SERVICE, AND JOHN J. FOREMAN, BUREAU OF INDIAN AFFAIRS

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, AND UNITED STATES DEPARTMENT OF THE INTERIOR, BUREAU OF INDIAN AFFAIRS, IN COOPERATION WITH UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

THURSTON COUNTY is in northeastern Nebraska (fig. 1) on the western banks of the Missouri River. The total land area is 248,320 acres, or 388 square miles. Pender, the county seat and largest town, is in the southwestern part of the county along Logan Creek.

The State and county boundaries shown on the maps in this publication are approximate along the Missouri River and along the borders where the county lines are not on the roads. The boundary shown between Nebraska and Iowa was plotted from a base map compiled by the U.S. Corps of Engineers, dated January 30, 1940. This boundary was established as the State line by the Iowa-Nebraska Boundary Compact of 1943.

The climate of the county is marked by fairly warm summers and cold winters. The average annual temperature is 49° F., and the average annual precipitation is 26 inches. Farming is the chief enterprise. Corn, sorghum, and soybeans, grown in rotation with small grains and alfalfa, are the chief crops. The growing of grain and the production of livestock are the main farm enterprises.

Most of the soils in the county formed under grass, though some of the soils on uplands along the bluffs formed partly under deciduous trees. The parent material was mainly loess, alluvium, glacial till, and eolian sand.

The soils in the county vary widely in characteristics, particularly the soils that formed in alluvium. The soils that formed in alluvium range from fine to coarse in texture throughout. They have slow to rapid permeability. Except for small areas of sandy soils, the soils on the uplands and terraces are fairly uniform in texture. They are medium textured to moderately fine textured throughout, and they have moderate to moderately slow permeability.

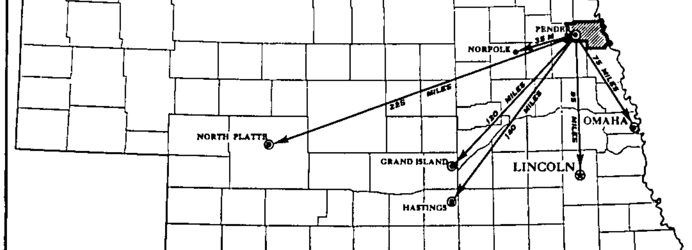

Figure 1.—**Location of Thurston County in Nebraska.**

All of the soils on the uplands are moderately well drained to well drained. Drainage of the soils on the bottom lands ranges from excessive in the very sandy soils to poor in the fine-textured soils.

Depth to the calcareous layer in the soils in the county is variable. Most of the soils on the bottom lands are calcareous at or near the surface. The steep and severely eroded soils on the uplands generally are calcareous throughout. The rest of the soils are noncalcareous in the surface layer, and some are noncalcareous in all or part of the subsoil. Most of the soils are calcareous at a depth between 2 and 10 feet.

The suitability of a soil for crops depends on the texture, structure, and reaction of the soil, as well as the slope, content of organic matter, and drainage. Many kinds of crops can be grown on deep, medium textured to moderately fine textured, well-drained soils that are level to sloping. The range of use is more limited on sandy and steep soils that erode readily if cultivated. Poorly drained soils cannot be used satisfactorily for cultivated crops until drainage is improved.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Thurston County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kind of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Crofton and Moody, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Crofton silt loam, 1 to 7 percent slopes, eroded, is one of several phases within the Crofton series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Thurston County—the soil complex and the undifferentiated group.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. An example is Belfore-Moody silty clay loams, 0 to 1 percent slopes.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Onawa and Haynie soils is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gullied land is a land type in Thurston County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Thurston County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Thurston County are discussed in the following pages. The terms for texture used in the title for each association apply to the surface layer. In the title for association 1, for example, the words "mixed silty and sandy" refer to texture of the surface layer.

1. Moody-Nora-Thurman Association

Well-drained, gently sloping to sloping, mixed silty and sandy soils on uplands

This association consists of deep, gently sloping to sloping, well-drained soils on hills in the uplands. These soils formed in silty loess and in sand. The areas range from 1 to 4 miles in width and are about 10 miles in length. They are dissected by an intricate pattern of drainageways. Drainage is into Logan and Middle Creeks. The soil pattern of this association is intricate, and the sandy soils occupy almost any position on the landscape.

This association covers an area of about 7,948 acres, or 3 percent of the county. Moody soils make up 50 percent of

this association, Nora soils 23 percent, and Thurman soils 11 percent. The remaining 16 percent is minor soils.

Moody soils formed in silty loess. Their surface layer generally is silty clay loam. In small areas, however, the surface layer is fine sandy loam, 6 to 14 inches thick. The subsoil in Moody soils is silty clay loam. The underlying material is light silty clay loam in the upper part and silt loam in the lower part.

Nora soils also formed in silty loess. They have a surface layer of silt loam and a subsoil of silty clay loam. The underlying material is calcareous, silt loam loess.

Thurman soils formed in reworked, loose, sandy deposits that cover the loess in scattered places. They have a surface layer of loamy fine sand and a subsoil of loamy sand. The underlying material is loose sand.

Minor soils of this association are mainly in the Judson, Ortello, and Crofton series. Judson soils are on the lower part of slopes or along drainageways, and Ortello soils are deep fine sandy loams on uplands (fig. 2). Crofton soils are deep, silty, calcareous soils on uplands.

Most of the acreage in this association is cultivated. Corn, alfalfa, and soybeans are the main crops. Water erosion is the principal hazard, but the hazard of soil blowing is moderate to severe on the sandy soils.

2. Judson-Kennebec-Lamo Association

Well drained to somewhat poorly drained, nearly level to gently sloping, silty soils along bottom lands and upland drainageways

Some of the soils in this association are nearly level and are along flood plains. Others are gently sloping and are adjacent to drainageways in the uplands. These soils are well drained to somewhat poorly drained. They formed in silty to clayey alluvium along the smaller streams, and in colluvium on the lower part of slopes (see fig. 2).

This association covers an area of about 41,048 acres, or about 17 percent of the county. Judson soils make up 25 percent of this association, Kennebec soils 23 percent, and Lamo soils 16 percent. Minor soils make up the remaining 36 percent.

Judson soils are well drained. They formed in silty colluvium on the lower part of slopes. These soils have a surface layer of silt loam and a subsoil of silty clay loam.

Kennebec soils are moderately well drained. They formed in silty deposits on flood plains along the major drainageways. They have a surface layer and subsoil of silt loam.

Lamo soils are somewhat poorly drained. They formed in silty to clayey deposits on flood plains. These soils have a

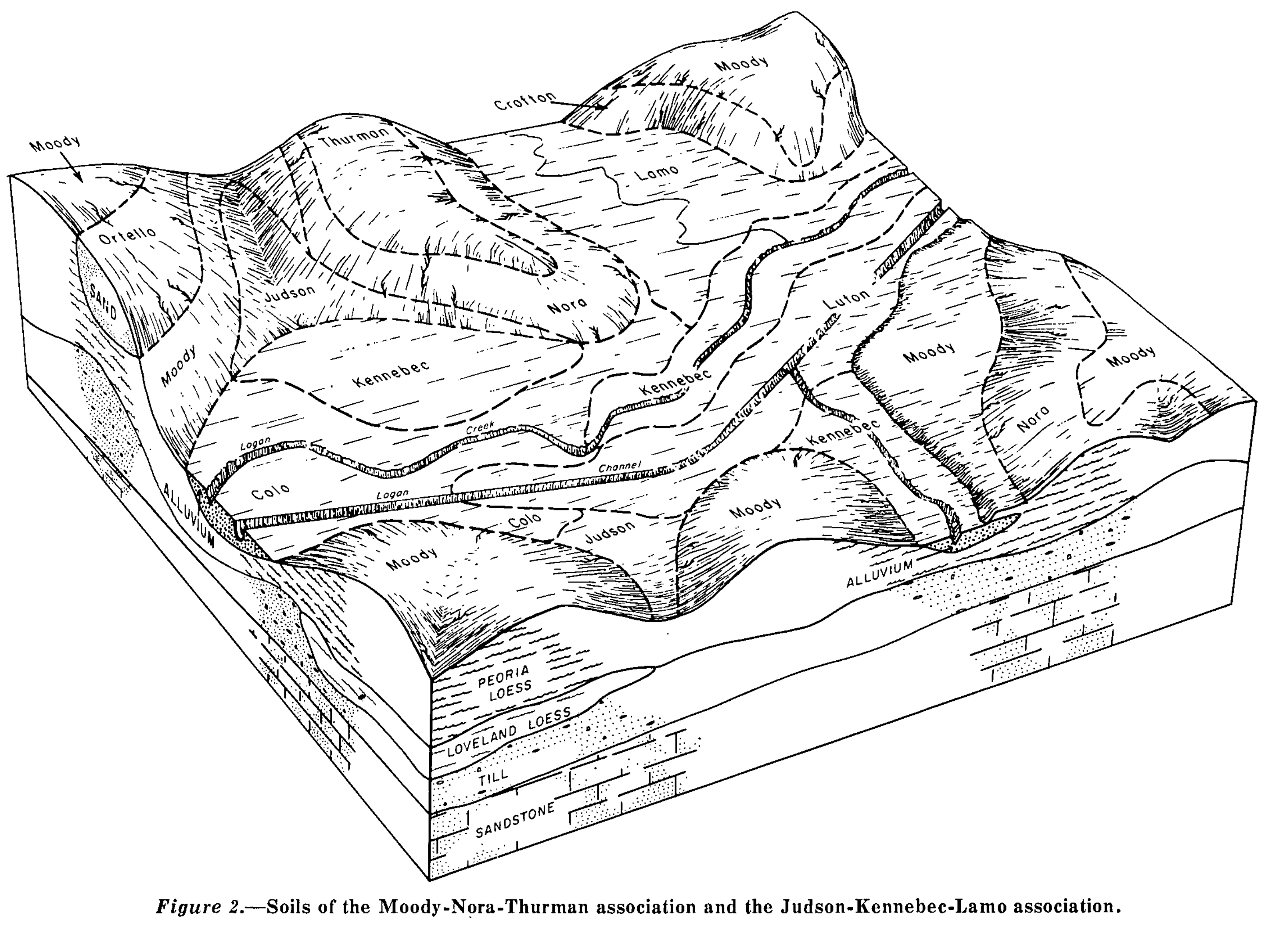

Figure 2.—Soils of the Moody-Nora-Thurman association and the Judson-Kennebec-Lamo association.

surface layer of silty clay loam or silt loam. Their subsoil is silty clay loam that generally is calcareous.

Minor soils in this association are the McPaul, Colo, Luton, and Zook, and the land type Silty alluvial land. McPaul soils occupy drainageways that are flooded occasionally. Silty alluvial land, on the other hand, is subject to frequent flooding. Colo, Zook, and Luton soils are poorly drained and are on bottom lands. They range from silty clay loam to silty clay and from noncalcareous to calcareous.

Most of the acreage in this association is cultivated. The major soils are highly fertile and are suited to all crops commonly grown in the county. The hazard of flooding and the lack of drainage are the main concerns of management. In some areas flooding and lack of drainage are not problems, and only good management is necessary for good growth of crops. Grain grown for cash and feeding livestock is the chief crop on most of the farms. On a few of the farms sufficient water for irrigating some crops is obtained from streams or wells.

3. Moody-Nora-Judson Association

Well-drained, nearly level to steep, silty soils on uplands

This association consists of nearly level to steep soils on uplands. These soils formed in loess and in colluvium (fig. 3). The areas are dissected by small streams and by upland drainageways. Also in the association are a few stream terrace areas that contain a few small depressions.

This association covers an area of about 122,720 acres, or about 49 percent of the county. Moody soils make up about 35 percent of this association, Nora soils 30 percent, and Judson soils 15 percent. Minor soils make up the remaining 20 percent.

Moody soils are well drained and are nearly level to strongly sloping. They formed in loess. Their surface layer and subsoil are silty clay loam. The underlying material is silt loam loess.

Nora soils are mostly sloping to moderately steep, but in some areas they are gently sloping and in others they are steep. These soils formed in loess. They have a surface layer of silt loam and a subsoil of silty clay loam that is calcareous in the lower part. The underlying material is calcareous silt loam loess.

Judson soils occur below Moody and Nora soils on the lower side slopes and along sloping drainageways. They are well drained. Their surface layer is silt loam, and their subsoil is silty clay loam.

Minor soils of this association are mostly in the Crofton, McPaul, Belfore, Lamo, and Colo series. Crofton soils are very thin, silty, and calcareous and are on uplands. McPaul, Lamo, and Colo soils occur along drainageways.

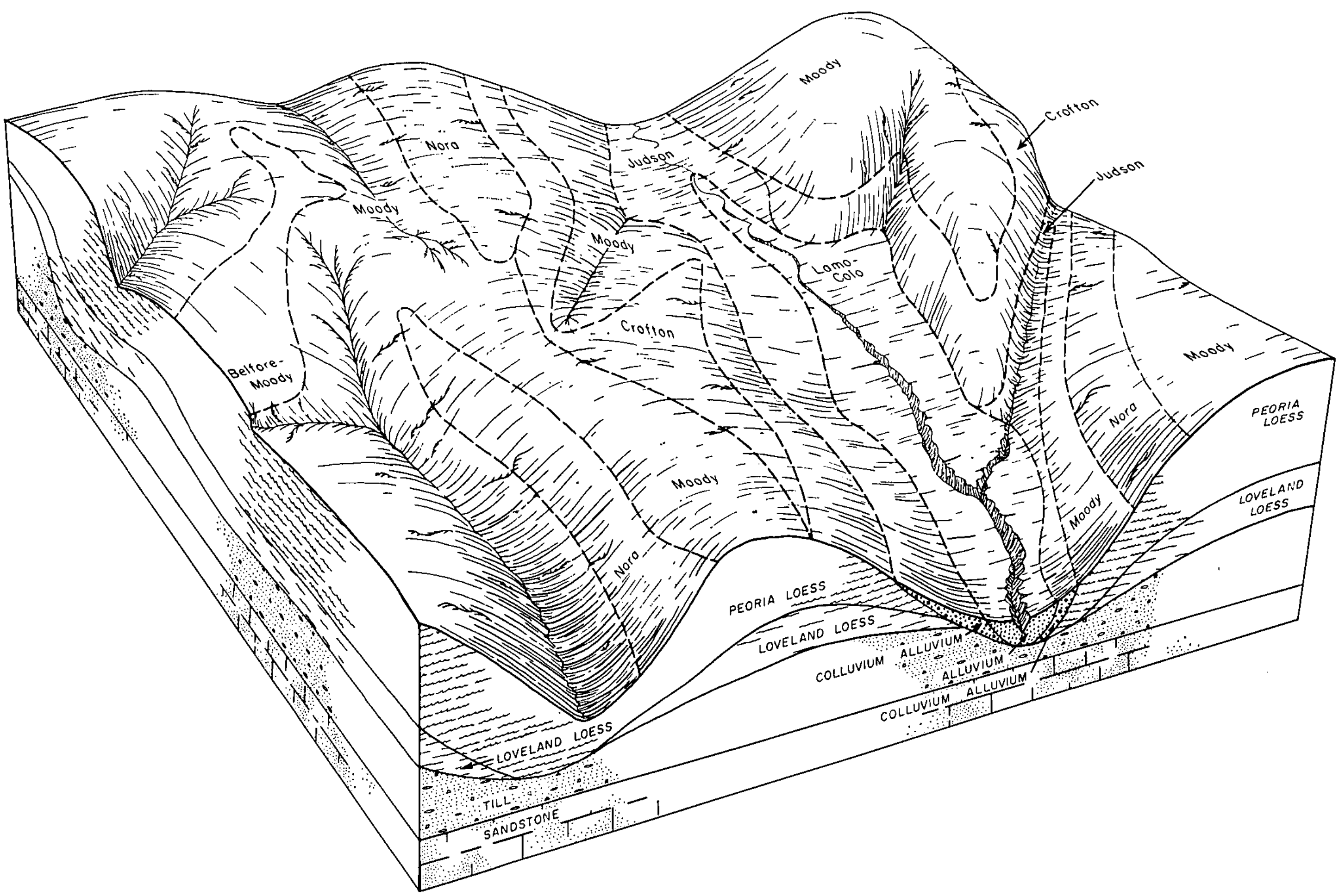

Figure 3.—**Soils of the Moody-Nora-Judson association.**

The nearly level Belfore soils occur in association with Moody soils on uplands.

Most of the acreage of this association is cultivated. The major soils are highly fertile and are well suited to all crops commonly grown in the county. The chief concerns of management are controlling erosion, conserving water, and maintaining fertility. Grain and forage crops are grown on most of the farms to provide feed for the livestock.

4. Monona-Ida Association

Well-drained, sloping to very steep, silty soils on uplands

This association consists primarily of deep, very friable, mostly sloping to very steep soils on uplands near the Missouri River (fig. 4). These soils formed in loess. The area is dissected by deeply entrenched drainageways.

This association covers an area of about 67,376 acres, or about 27 percent of the county. Monona soils make up 53 percent of this association, and Ida soils 25 percent. The remaining 22 percent is minor soils.

Monona soils have a surface layer and subsoil of silt loam. Slopes range from gently sloping to steep.

Ida soils have a thin surface layer of silt loam that is underlain by calcareous silt loam loess. Slopes range from sloping to steep.

Minor soils in this association are the Judson, McPaul, Burchard, Kennebec, and Steinauer, and the land type Gullied land. Judson soils formed in colluvium and are on the lower part of slopes. Burchard and Steinauer soils formed in glacial soil material that in places is exposed on side slopes below the Monona and Ida soils (fig. 5). McPaul and Kennebec soils occupy drainageways subject to some flooding.

Sloping areas in this association that are suitable for cultivation are used mainly to grow cash-grain crops. Corn is the principal crop and is grown in a cropping system that includes oats and alfalfa. Grain sorghum and soybeans are also grown. Large areas are in tame grasses and native grasses, but some areas are wooded.

5. Albaton-Haynie Association

Poorly drained and moderately well drained, nearly level, clayey to loamy soils on river bottoms

This association consists of nearly level soils on bottom lands along the Missouri River (fig. 6). These soils formed in alluvial sediment laid down by floods. Structures built along the Missouri River for flood control and river stabilization have minimized the flooding that until recently deposited the sediment in which these soils formed.

This association covers about 9,228 acres, or 4 percent of the county. Albaton soils make up 27 percent of this association, and Haynie soils 27 percent. The remaining 46 percent is minor soils.

Albaton soils are poorly drained. Their surface layer

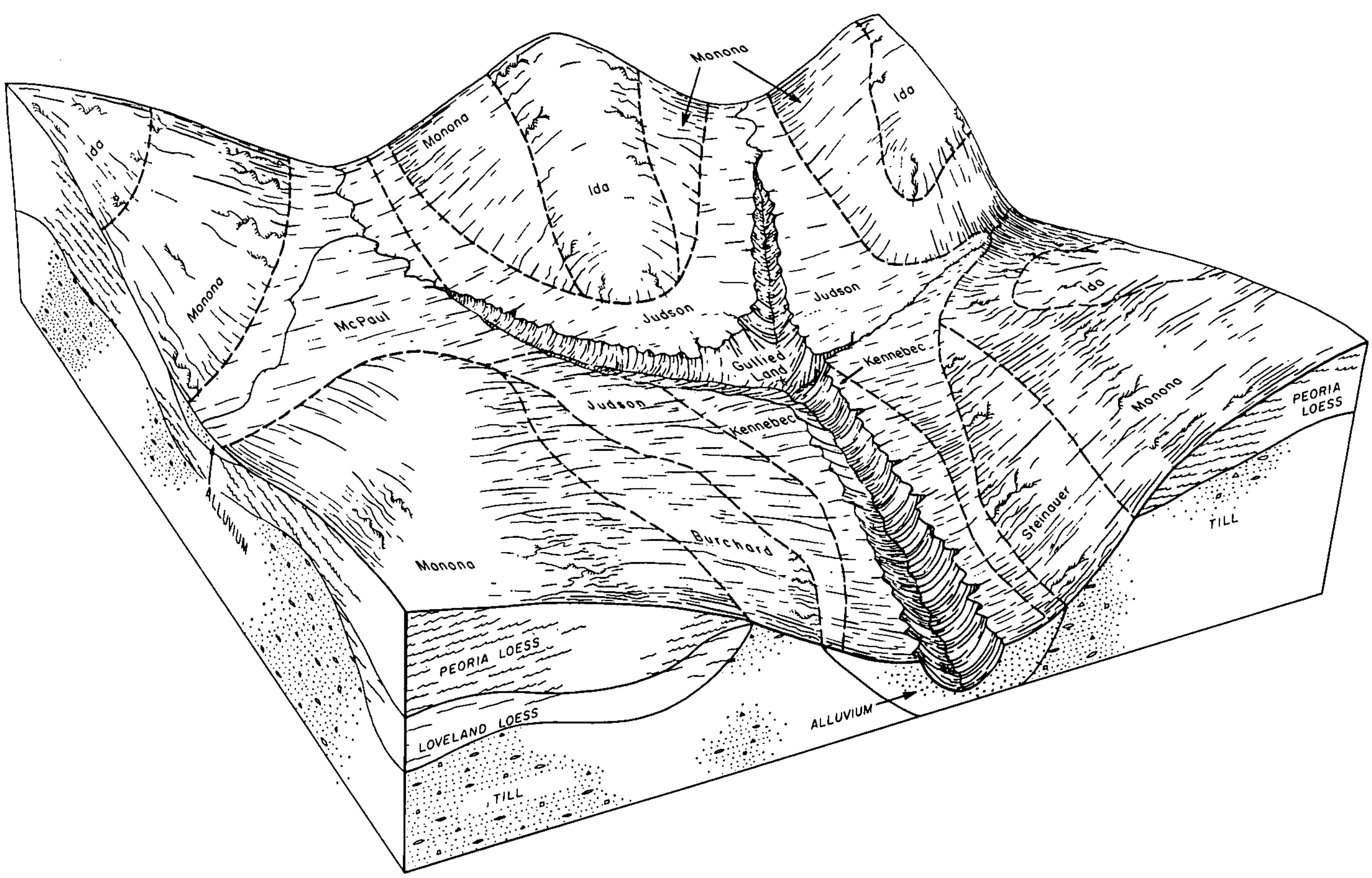

Figure 4.—**Soils of the Monona-Ida association.**

Figure 5.—**Deciduous woodland on soils in association 4 in the northeastern part of the county.**

and subsoil are silty clay. They have a water table at a depth of 5 feet or more.

Haynie soils are moderately well drained. They have a surface layer of silt loam and a subsoil of very fine sandy loam.

Minor soils of this association are the Onawa, Sarpy, and McPaul and the land types Wet alluvial land, Marsh, and Riverwash. Onawa soils occupy positions similar to those occupied by Albaton soils, but they have a medium-textured substratum. Sarpy soils formed in recent deposits of sand and generally are adjacent to or near the old river channel in the same positions as the Albaton and Haynie soils. McPaul soils occur where streams enter from uplands.

Marsh occurs along old stream channels only a few feet above the normal flow of the river. Riverwash consists of unstabilized sand that was deposited by rivers relatively recently. Wet alluvial land generally is in old low stream channels and in seepage areas adjacent to bluffs.

This association generally is level or nearly level, though remnants of former channels and slight ridges from old flood deposits are present. The water table fluctuates with the level of the Missouri River.

The major soils are suited to all crops commonly grown in the county. Sarpy soils, however, are not so well suited to corn and soybeans as the other soils, because they are low in available water capacity. The land types are better suited to grass, trees, wildlife, and recreational areas than to other uses. Several areas of trees still remain in this association (fig. 7). Drainage is needed and must be maintained if the areas are used for crops.

Much of this association consists of tribal land owned by the Omaha and Winnebago Indians. Few farmsteads are in this association. The cropland is used mostly for cash-grain farming.

Descriptions of the Soils

In this section the soil series and mapping units of Thurston County are described in alphabetical order. The procedure is to describe first the soil series, and then the mapping units in that series. Thus, to get full information on any mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which the unit belongs.

Each series contains a short description of a representative soil profile and a much more detailed description of the same profile that scientists, engineers, and others can use in making highly technical interpretations. If the profile of a given mapping unit differs from the representative profile, the differences are stated in the description of the mapping unit or they are apparent in the name of the mapping unit. The colors described are for dry soil, unless otherwise noted.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil

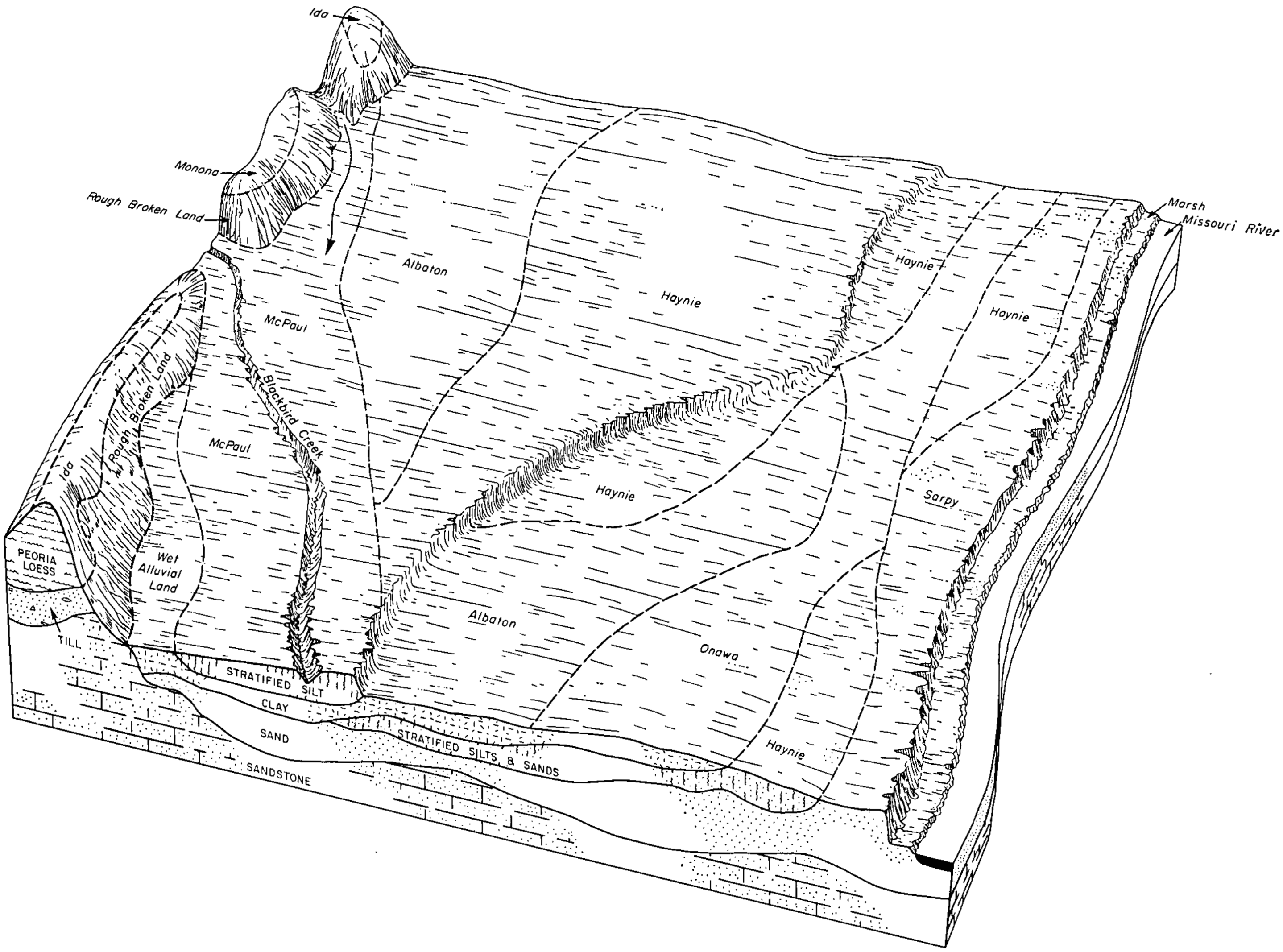

Figure 6.—**Soils of the Albaton-Haynie soil association.**

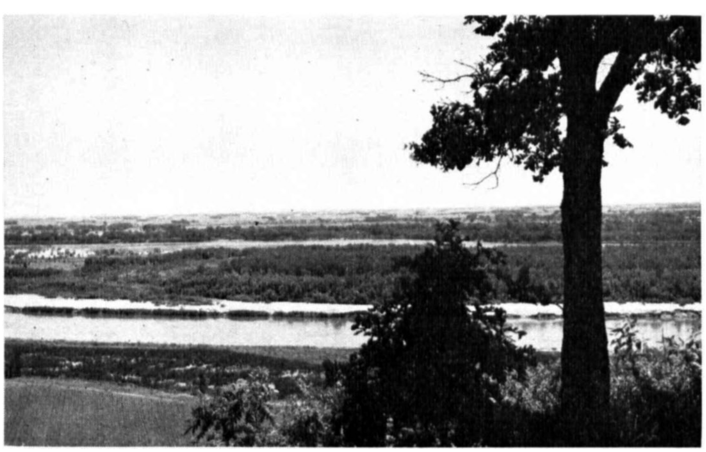

Figure 7.—**Patches of trees on the Missouri River bottom land east of Winnebago in the Albaton-Haynie soil association.**

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series. Rough broken land, for example, does not belong to a soil series, but nevertheless, it is listed in alphabetical order along with the soil series.

Many of the terms used in describing the soil series and the mapping units are defined in the Glossary and are described more fully in the Soil Survey Manual (*6*).[1] Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map, which is at the back of this survey. The approximate acreage and proportionate extent of the mapping units are shown in table 1. All of the mapping units in the county are listed in the "Guide to Mapping Units" at the back of this survey, which also shows the capability unit, range site, and windbreak suitability group each mapping unit is in.

[1] Italic numbers in parentheses refer to Literature Cited, p. 63.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Albaton silty clay	2, 087	0. 8
Albaton silty clay loam	527	. 2
Belfore-Moody silty clay loams, 0 to 1 percent slopes	1, 874	. 8
Burchard clay loam, 11 to 17 percent slopes, eroded	1, 571	. 6
Burchard silt loam, 5 to 11 percent slopes	226	. 1
Burchard silt loam, 11 to 17 percent slopes	297	. 1
Colo silty clay loam	2, 956	1. 2
Crofton silt loam, 1 to 7 percent slopes, eroded	887	. 4
Crofton silt loam, 7 to 11 percent slopes, eroded	5, 747	2. 3
Crofton silt loam, 11 to 17 percent slopes, eroded	11, 149	4. 5
Crofton silt loam, 17 to 31 percent slopes, eroded	2, 047	. 8
Gullied land	5, 929	2. 4
Haynie silt loam	2, 769	1. 1
Ida silt loam, 7 to 11 percent slopes, eroded	1, 067	. 4
Ida silt loam, 11 to 17 percent slopes	616	. 2
Ida silt loam, 11 to 17 percent slopes, eroded	10, 410	4. 2
Ida silt loam, 17 to 31 percent slopes	1, 203	. 5
Ida silt loam, 17 to 31 percent slopes, eroded	3, 053	1. 2
Judson silt loam, 0 to 2 percent slopes	2, 353	. 9
Judson silt loam, 2 to 7 percent slopes	28, 556	11. 5
Kennebec silt loam	9, 490	3. 8
Lamo silt loam, overwash	3, 346	1. 3
Lamo silty clay loam	3, 107	1. 2
Luton silty clay loam	1, 085	. 4
Luton silty clay	1, 150	. 5
Marsh	1, 144	. 5
McPaul silt loam	9, 576	3. 9
Monona silt loam, 1 to 7 percent slopes	1, 503	. 6
Monona silt loam, 1 to 7 percent slopes, eroded	1, 539	. 6
Monona silt loam, 7 to 11 percent slopes	10, 585	4. 3
Monona silt loam, 7 to 11 percent slopes, eroded	3, 297	1. 3
Monona silt loam, 11 to 17 percent slopes	6, 454	2. 6
Monona silt loam, 11 to 17 percent slopes, eroded	7, 685	3. 1
Monona silt loam, 17 to 31 percent slopes	4, 481	1. 8
Moody silty clay loam, 0 to 1 percent slopes	3, 612	1. 5
Moody silty clay loam, 1 to 7 percent slopes	9, 231	3. 7
Moody silty clay loam, 1 to 7 percent slopes, eroded	3, 454	1. 4
Moody silty clay loam, 7 to 11 percent slopes	20, 697	8. 3
Moody silty clay loam, 7 to 11 percent slopes, eroded	11, 465	4. 6
Moody fine sandy loam, 7 to 11 percent slopes	1, 051	. 4
Nora silt loam, 1 to 7 percent slopes, eroded	2, 409	1. 0
Nora silt loam, 7 to 11 percent slopes	2, 088	. 8
Nora silt loam, 7 to 11 percent slopes, eroded	11, 913	4. 8
Nora silt loam, 11 to 17 percent slopes	2, 464	1. 0
Nora silt loam, 11 to 17 percent slopes, eroded	15, 480	6. 2
Nora silt loam, 17 to 31 percent slopes, eroded	1, 877	. 8
Onawa silty clay	944	. 4
Onawa and Haynie soils	903	. 4
Ortello fine sandy loam, 2 to 5 percent slopes	144	. 1
Ortello fine sandy loam, 5 to 11 percent slopes, eroded	504	. 2
Riverwash	761	. 3
Rough broken land	1, 165	. 5
Sarpy soils	361	. 1
Silty alluvial land	2, 157	. 9
Steinauer soils, 11 to 30 percent slopes	679	. 3
Thurman loamy sand, 1 to 7 percent slopes	407	. 2
Thurman soils, 7 to 17 percent slopes	890	. 4
Wet alluvial land	652	. 3
Zook silty clay loam	2, 215	. 9
Zook silty clay	793	. 3
Streams and stream channels	238	. 1
Total	248, 320	100. 0

Albaton Series

The Albaton series consists of nearly level to depressional, poorly drained, calcareous soils. These soils formed in recent fine-textured slackwater sediment laid down along the Missouri River. Depth to the water table normally is more than 5 feet, and the lower depressional areas are subject to occasional flooding.

In a representative profil, the surface layer is grayish-brown light silty clay about 9 inches thick. Below this to a depth of 30 inches is silty clay that is light brownish gray in the upper 6 inches; dark gray at a depth between 15 and 24 inches; and grayish brown in the lower 6 inches. Between a depth of 30 and 60 inches is stratified silt loam, silty clay, and silty clay loam. This material is light brownish gray in the upper part and grayish brown in the lower part.

Available water capacity is high. Permeability is slow. Fertility is moderate. If these soils are drained, they are suited to all crops commonly grown in the county.

Representative profile of Albaton silty clay in a cultivated field (0.3 mile east and 100 feet south of the northwest corner of sec. 28, T. 25 N., R. 10 E.):

Ap—0 to 9 inches, grayish-brown (2.5Y 5/2) light silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, subangular blocky structure that breaks to moderate, fine, angular blocky; hard when dry, firm when moist; strongly calcareous; mildly alkaline; abrupt, smooth boundary.

C1—9 to 15 inches, light brownish-gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate, coarse, angular blocky structure that breaks to weak, fine, angular blocky; extremely hard when dry, firm when moist; strongly calcareous; mildly alkaline; diffuse, wavy boundary.

C2g—15 to 24 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate, fine, angular blocky structure that breaks to weak, very fine, granular; extremely hard when dry, firm when moist; a few, fine, distinct, red mottles; slightly calcareous; mildly alkaline; clear, smooth boundary.

C3g—24 to 30 inches, grayish-brown (2.5Y 5/2, dry and moist) silty clay; moderate, medium, angular blocky structure that breaks to weak, fine, angular blocky; extremely hard when dry, firm when moist; a few, fine, distinct, red mottles; slightly calcareous; mildly alkaline; clear, smooth boundary.

IIC4g—30 to 33 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, platy structure that breaks to massive; soft when dry, very friable when moist; a few, fine, distinct, red mottles; strongly calcareous; mildly alkaline; clear, smooth boundary.

IIIC5g—33 to 48 inches, grayish-brown (2.5Y 5/2) silty clay; moderate, medium, angular blocky structure that breaks to moderate and fine, angular blocky; extremely hard when dry, firm when moist; common, medium, distinct, red mottles; strongly calcareous; moderately alkaline; clear, smooth boundary.

IIIC6—48 to 60 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, angular blocky structure; extremely hard when dry, firm when moist; strongly calcareous; moderately alkaline; clear, smooth boundary.

The A horizon ranges from 6 to 10 inches in thickness and from silty clay loam to clay in texture. It is grayish brown to dark grayish brown. In areas that have not received recent deposits, the A horizon is darker colored than in the representative profile and contains more organic matter.

The C horizon consists of stratified layers of predominantly clay or silty clay to a depth of about 48 inches, but in places thin horizons of silt loam or silty clay loam are present. In places sandy horizons occur below a depth of 48 inches. The C horizon ranges from dark gray to light brownish gray. Mottling generally occurs in most or all of the horizons below the surface horizon. The profile is calcareous throughout.

Albaton soils are near Haynie, Onawa, and Sarpy soils and the land type Wet alluvial land. They formed in thicker clay deposits than Onawa soils and lack the underlying coarse material typical of those soils. Onawa soils contain more clay throughout than the Haynie and Sarpy soils. They are not so poorly drained as Wet alluvial land.

Albaton silty clay loam (0 to 1 percent slopes) (Am).—This soil has a surface layer of light silty clay loam that ranges from about 7 to 10 inches in thickness, but its profile otherwise is similar to that described as representative of the series. In places flooding has deposited a thin cover of sandy overwash on this soil.

This soil is easy to till, and it is suited to all crops commonly grown in the county. The main concerns of management are drainage and maintaining fertility. Capability unit IIIw-2; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Albaton silty clay (0 to 1 percent slopes) (Ak).—This soil is on bottom lands. It has the profile described as representative of the series. The surface layer ranges from silty clay to clay. Permeability and runoff are slow.

Included with this soil in mapping are small areas of Onawa soils. These areas make up about 15 percent of the acreage.

The surface layer of this soil dries slowly. As a result, the soil tends to be cold and wet, planting is likely to be delayed in spring, and the stands are uneven. As this soil dries large cracks form and injure the root system of the plants. Soil structure can be improved by plowing in fall, adding manure, returning crop residues to the soil, and seeding legumes. Corn, soybeans, wheat, sorghums, and alfalfa are suitable crops. The natural vegetation was trees, and some areas are still wooded. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Belfore Series

The Belfore series consists of deep, moderately well drained soils. These soils formed in Peoria loess.

In a representative profile the surface layer is very dark grayish-brown silty clay loam about 10 inches thick. The subsoil is dark grayish-brown silty clay loam in the upper 4 inches; light silty clay to a depth of 30 inches that is grayish brown in the upper part and brown in the lower part; and yellowish-brown silty clay loam to a depth of 47 inches. The underlying material is light yellowish-brown silt loam.

These soils are high in natural fertility. They retain and store moisture well. The available water capacity is high. Permeability is moderately slow.

Belfore soils are well suited to all crops commonly grown in the county, and most areas are cultivated. The natural vegetation on these soils was tall prairie grasses.

Representative profile of Belfore silty clay loam in an area of Belfore-Moody silty clay loams, 0 to 1 percent slopes, in a cultivated field (0.25 mile east and 50 feet north of the southwest corner of sec. 36, T. 25 N., R. 5 E.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure that breaks to weak, medium and fine, granular; slightly hard when dry, friable when moist; slightly acid; abrupt, smooth boundary.

A1—7 to 10 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong, medium and fine, subangular blocky structure that breaks to moderate, fine, granular; slightly hard when dry, firm when moist; slightly acid; abrupt, smooth boundary.

B1—10 to 14 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium and fine, subangular blocky structure; slightly hard when dry, firm when moist; slightly acid; clear, smooth boundary.

B21t—14 to 20 inches, grayish-brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that breaks to moderate, medium and fine, subangular blocky; slightly hard when dry, firm when moist; patchy clay films on vertical faces; slightly acid; clear, smooth boundary.

B22t—20 to 30 inches, brown (10YR 5/3) light silty clay, dark brown (10YR 4/3) when moist; moderate, coarse, prismatic structure that breaks to moderate, medium and fine, subangular blocky to blocky; hard when dry, firm when moist; a few fine pores; moderately thick, continuous clay films on horizontal and vertical faces; slightly acid; clear, smooth boundary.

B23t—30 to 35 inches, yellowish-brown (10YR 5/4) heavy silty clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, coarse, subangular blocky structure that breaks to moderate, medium and fine, subangular blocky; hard when dry, firm when moist; a few, fine pores; moderately thick, continuous clay films on vertical faces; neutral; clear, smooth boundary.

B3—35 to 47 inches, yellowish-brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) when moist; weak, coarse, subangular blocky structure that breaks to weak, moderate and fine, subangular blocky; slightly hard when dry, friable when moist; a few, fine pores; patchy, very thin clay films on vertical faces; a few, fine, faint gray mottles; neutral; clear, smooth boundary.

C—47 to 60 inches, light yellowish-brown (10YR 6/4) silt loam, dark yellowish brown (10YR 4/4) when moist; massive; soft when dry, very friable when moist; mildly alkaline.

The A horizon ranges from subangular blocky to granular in structure. It ranges in thickness from 8 inches on the low ridges to 16 inches in the swales. The B horizon ranges from silty clay loam to silty clay in texture. Its color ranges from dark grayish brown or brown in the upper part to yellowish brown, brown, or grayish brown in the lower part. Structure ranges from weak to moderate, subangular blocky in the upper and lower horizons to strong subangular or angular blocky in the middle horizons. The thickness of the B horizon ranges from 30 to 48 inches. The C horizon ranges from light yellowish brown to yellowish brown. Its texture ranges from silt loam to light silty clay loam.

Belfore soils are on level or nearly level divides or high terraces and are near Moody and Nora soils. They are more leached than those soils and have a finer textured subsoil.

Belfore-Moody silty clay loams, 0 to 1 percent slopes (BM).—These soils are on broad divides on uplands and on terraces and terrace remnants. About 60 percent of the complex is Belfore soils, and 40 percent is Moody soils. Each of the soils has the profile described as representative of their respective series. Runoff is slow on these soils. The hazard of erosion is slight to none.

Included with these soils in mapping are a few potholes or depressional areas. These included areas are indicated on the map by a spot symbol.

The soils in this complex are highly productive and are suited to all crops commonly grown in the county. Maintaining fertility is the main concern of management. Capability unit I–1; Silty range site; Silty to Clayey windbreak suitability group.

Burchard Series

The Burchard series consists of deep, moderately sloping to strongly sloping, well-drained soils on uplands. These soils formed in glacial till under mid and tall grasses. They are along deeply entrenched streams in the southeastern part of the county.

In a representative profile the surface layer is about 13 inches thick. It is dark-gray silt loam in the upper part and dark grayish-brown silty clay loam in the lower part. In places a few small rocks and pebbles are on the surface. The subsoil, about 31 inches thick, is grayish brown in the upper part and brown and pale brown in the middle and lower parts. Texture of the subsoil is friable clay loam. The subsoil contains small particles of segregated lime below a depth of 28 inches and is calcareous. Calcareous light-gray clay loam till is at a depth below 44 inches.

The available water capacity is high in these soils. Permeability is moderately slow. Fertility is moderate. Water erosion is the main concern of management.

Representative profile of Burchard silt loam, 11 to 17 percent slopes, in a cultivated field (150 feet north and 200 feet west of the southeast corner of the SW¼ of sec. 9, T. 25 N., R. 9 E.):

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine and medium, granular structure; soft when dry, friable when moist; neutral; abrupt, smooth boundary.

A1—6 to 13 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky; soft when dry, very friable when moist; neutral; clear, smooth boundary.

B1—13 to 20 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium and fine, prismatic structure that breaks to weak, medium, subangular blocky; slightly hard when dry, very friable when moist; a few, thin, patchy clay films; mildly alkaline; clear, smooth boundary.

B21t—20 to 28 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; weak, very fine, prismatic structure that breaks to weak, fine, subangular blocky; slightly hard when dry, friable when moist; lime segregated and disseminated; lime segregations are soft, white, and about one-half inch or less in diameter; thin, continuous clay films; a few pebbles as much as 2 inches in diameter; a few, fine, faint, red mottles; strongly calcareous; moderately alkaline; gradual, smooth boundary.

B22t—28 to 44 inches, pale-brown (10YR 6/3) clay loam, light olive brown (2.5Y 5/4) when moist; moderate to strong, fine, subangular blocky structure; hard when dry, friable when moist; soft, white lime that is segregated and disseminated; thin continuous clay films; some pebbles as much as 2 inches in diameter; a few, fine, faint, red mottles; strongly calcareous; moderately alkaline; clear, smooth boundary.

C—44 to 60 inches, light-gray (10YR 7/1) clay loam, grayish brown (10YR 5/2) when moist; massive; hard when dry, friable when moist; disseminated lime; a few, fine faint, reddish-yellow mottles; strongly calcareous; moderately alkaline.

Depth to lime ranges from 13 to 30 inches. Thickness of the A horizon ranges from 7 inches in the steeper eroded soils to 14 inches in the gently sloping uneroded soils. The A horizon ranges from loam or silt loam to light clay loam or silty clay loam. Its color ranges from very dark gray or dark gray in the uneroded soils to gray or dark grayish brown in the eroded soils. The B horizon is mainly clay loam, but it ranges locally to sandy clay or silty clay. Its color ranges from pale brown to dark brown. This horizon generally is calcareous in the lower part. The C horizon ranges from grayish brown to light gray and has a reddish to brown cast in places. Pockets of sand and of small pebbles and boulders occur in places. Segregated lime generally is abundant, but it is lacking in places. The underlying material is calcareous.

The Burchard soils are near the Steinauer, Monona, Nora, Crofton, and Ida soils. They are deeper than Steinauer soils and formed from similar glacial material. Unlike the Monona, Nora, Crofton, and Ida soils, which formed in loess laid down on glacial material, Burchard soils formed entirely from glacial material.

Burchard silt loam, 5 to 11 percent slopes (BnC).—This soil is in slightly concave areas that range from 3 to 5 acres. Runoff is slow to medium.

The surface layer of this soil ranges from 7 to 10 inches in thickness. It is friable and is easy to work. The subsoil ranges from 20 to 30 inches in thickness. The upper part is clay loam, and the lower part is clay loam, silty clay, or sandy clay. Roots penetrate the subsoil easily. Lime occurs at a depth of about 20 inches.

Included with this soil in mapping are Steinauer soils on convex slopes or near the upper part of slopes, and Nora and Monona soils at the base of slopes along drainageways.

This Burchard soil is well suited to all crops commonly grown in the county. Management is difficult because the areas are small. The main concerns of management are controlling erosion and maintaining fertility. Capability unit IIIe–1; Silty range site; Silty to Clayey windbreak suitability group.

Burchard silt loam, 11 to 17 percent slopes (BnD).—This soil has the profile described as representative of the series. It is on uplands. Runoff is rapid.

Most areas of this soil are in native grass or trees, but some areas are cultivated. Corn, sorghum, small grains, and alfalfa are suitable crops. The soil is better suited, however, to grass and hay crops than to cultivated crops. If this soil is cultivated, erosion is a severe hazard. Capability unit IVe–1; Silty range site; Silty to Clayey windbreak suitability group.

Burchard clay loam, 11 to 17 percent slopes, eroded (BdD2).—This soil is on uplands. Runoff is rapid, and the soil is moderately eroded to severely eroded. The areas generally are less than 5 acres in size.

The surface layer of this soil is dark grayish-brown clay loam about 7 inches thick. In severely eroded areas the subsoil is exposed in places, and the texture is slightly heavier and tilth is more difficult. The subsoil is about 15 to 20 inches thick. Lime is at a depth of 15 to 24 inches.

Included with this soil in mapping are small areas of Monona and Steinauer soils. Also included are areas of clay and shale material and some places where layers of limestone and sandstone crop out.

The hazard of further erosion makes this Burchard soil suitable only for limited cultivation. This soil is better suited to grass and hay than to cultivated crops. Corn, sorghum, and small grains are suitable crops if the soil is cultivated. Capability unit IVe–8; Silty range site; Silty to Clayey windbreak suitability group.

Colo Series

The Colo series consists of deep, nearly level to very gently sloping, poorly drained soils. These soils are on first bottoms and low terraces along large upland drainageways throughout the county. They formed in alluvium under mid and tall grasses and are leached of lime.

In a representative profile the surface layer is silty clay loam about 29 inches thick. It is dark gray in the upper 4 inches and very dark gray below. At a depth between 29 and 40 inches is grayish-brown firm silty clay loam. The substratum is gray silty clay loam at a depth between 40 and 60 inches and light brownish-gray silt loam at a depth between 60 and 72 inches.

Colo soils generally are moderately wet and have a water table at a depth of about 5 feet. Permeability is moderately slow. Runoff is slow. Available water capacity and fertility are high.

Most areas of Colo soils are cultivated. Colo soils are better suited to corn, soybeans, sorghums, and alfalfa than to other crops. The natural vegetation on these soils was tall prairie grass.

Representative profile of Colo silty clay loam (400 feet east and 150 feet north of the southwest corner of sec. 1, T. 26 N., R. 5 E.):

A11—0 to 4 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; hard when dry, friable when moist; slightly acid; gradual, smooth boundary.

A12—4 to 13 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, medium and fine, subangular blocky structure that breaks to weak, medium, granular; hard when dry, firm when moist; neutral; gradual, smooth boundary.

A13—13 to 29 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, coarse, blocky structure that breaks to moderate, medium to fine, subangular blocky; slightly hard when dry, firm when moist; slightly acid; gradual, smooth boundary.

AC—29 to 40 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark brown (10YR 2/2) mixed with dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, subangular blocky; slightly hard when dry, firm when moist; mildly alkaline; gradual, smooth boundary.

C1g—40 to 60 inches, gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) when moist; weak, medium and fine, subangular blocky structure; slightly hard when dry, firm when moist; many, fine, distinct, dark-brown mottles; mildly alkaline; clear, smooth boundary.

C2g—60 to 72 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; massive; slightly hard when dry, firm when moist; many, fine, distinct, gray mottles and common, fine, prominent, dark reddish-brown mottles; mildly alkaline.

The A11 horizon ranges from silty clay loam to heavy silt loam, depending upon the texture of the most recent alluvial deposits. Its color ranges from very dark gray to very dark brown, though in places overwash is on the soil and it ranges from grayish brown to dark grayish brown. The A12 and A13 horizons typically are silty clay loam that ranges from very dark gray to grayish brown and gray.

The texture of the AC horizon and of the underlying horizons is silty clay loam, but in places strata of silt loam occur in these horizons. The color of these horizons ranges from dark gray to light brownish gray.

The Colo soils are near the Lamo and Kennebec soils. They are similar to the Lamo soils in texture, but those soils are calcareous. Colo soils are not so well drained as Kennebec soils but are somewhat finer textured.

Colo silty clay loam (0 to 1 percent slopes) (Ct).—This is the only Colo soil mapped in the county. Runoff is slow.

Included with this soil in mapping are small areas of Lamo and Kennebec soils.

Most areas of this soil are cultivated, but some are used for pasture. Corn, sorghums, soybeans, and alfalfa are better suited than other cultivated crops. In wet years crops may be damaged from too much moisture, but in drier years crops are likely to benefit because plants can obtain moisture from the underlying water table. The main concerns of management are providing adequate drainage and maintaining fertility. Capability unit IIw-4; Subirrigated range site; Moderately Wet windbreak suitability group.

Crofton Series

The Crofton series consists of deep, highly calcareous, friable, well-drained soils on uplands. These soils are gently sloping to steep. They formed in loess under mid and tall grasses.

In a representative profile (fig. 8) the surface layer is dark grayish-brown silt loam about 7 inches thick. Below is grayish-brown, very friable silt loam about 5 inches

Figure 8.—**Profile of a Crofton silt loam.**

thick that has lime concretions scattered throughout. The substratum is pale-brown silt loam at a depth between 12 and 20 inches. Below this to a depth of 60 inches it is light yellowish-brown, calcareous silt loam loess.

These soils are low in natural fertility. They contain little organic matter. Permeability is moderate, and available water capacity is high. These soils generally occupy the upper part of slopes and are very susceptible to sheet and rill erosion.

All major crops in the county can be grown on the gently sloping to moderately steep soils, though the hazard of erosion is severe if the soils are cultivated. The steep or severely eroded soils are better suited to native grasses than to cultivated crops. The native grasses are big bluestem, little bluestem, indiangrass, switchgrass, and side-oats grama.

Representative profile of a Crofton silt loam (650 feet north and 100 feet east of the southwest corner of section 9, T. 26 N., R. 7 E.):

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; clear, smooth boundary.

AC—7 to 12 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; lime concretions one-fourth inch in diameter; strongly calcareous; moderately alkaline; clear, smooth boundary.

C1—12 to 20 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure that breaks to massive; soft when dry, very friable when moist; light brownish-gray and brown, common, medium, distinct mottles; strongly calcareous; small lime concretions; some black concretions; strongly alkaline.

C2—20 to 60 inches, light yellowish-brown (2.5Y 6/4) silt loam, light olive brown (2.5Y 5/3) when moist; massive; soft when dry; very friable when moist; light brownish-gray and brown, common, medium, distinct mottles; some black concretions; strongly calcareous; strongly alkaline.

The A horizon ranges from dark grayish brown to grayish brown in cultivated areas and from dark gray to very dark brown in areas not cultivated. The texture of the A horizon and of the underlying material is silt loam, and the texture is about the same throughout the profile. The C horizon ranges from very pale brown to light olive brown. Lime is on the surface in eroded areas and at a depth between 6 and 10 inches in undisturbed areas. The lime occurs as concretions or is disseminated in the soil material.

Crofton soils formed under a somewhat less humid climate than Ida soils and generally are less leached than those soils. They are near Nora soils in the western part of the county and near Monona soils in the eastern part of the county. Crofton soils have a thinner and lighter colored A horizon than Nora soils, and depth to lime in the profile is less. They lack the stones or pebbles that are in Steinauer soils, which formed from calcareous glacial till.

Crofton silt loam, 1 to 7 percent slopes, eroded (CfB2).—This soil is on narrow, rounded ridgetops. Runoff generally is medium. The surface layer is grayish brown and ranges from 4 to 6 inches in thickness. It is friable, is easy to work, and generally is calcareous at the surface. The underlying loess is exposed in many places. In some areas lime concretions are more abundant on the surface than throughout the profile.

This soil is suited to all crops commonly grown in the county. The slope and silty texture make this very friable soil susceptible to sheet and rill erosion. The main concerns of management are preventing further erosion and maintaining fertility. Capability unit IIIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Crofton silt loam, 7 to 11 percent slopes, eroded (CfC2).—This soil has the profile described as representative of the series. It is on rounded ridgetops and convex slopes. The most common slope is 10 percent. Runoff generally is medium to rapid.

The original dark-colored surface soil has been removed by water erosion, and the lighter colored, calcareous underlying material is exposed.

Included with this soil in mapping are small areas of Moody and Nora soils.

This Crofton soil is suited to all crops commonly grown in the county, and most areas are cultivated. It is low in nitrogen and in content of organic matter. The main concerns of management are preventing further sheet erosion and maintaining fertility. Capability unit IVe-8; Limy Upland range site; Silty to Clayey windbreak group.

Crofton silt loam, 11 to 17 percent slopes, eroded (CfD2).—This soil is on sharp ridgetops and convex side slopes. Runoff is rapid, and the hazard of further erosion is severe.

The original dark-colored surface layer of this soil has been removed by water erosion, and the silty underlying material is exposed. The surface layer consists of calcareous, grayish-brown silt loam about 6 inches thick. It is underlain by pale-brown silt loam loess in which the soil formed.

Included with this soil in mapping are small areas of Nora and Moody soils.

This Crofton soil is suited to all crops commonly grown in the county. Because the hazard of further erosion is severe, this soil is better suited to grass and hay crops than to cultivated crops. The main concerns of management are preventing further erosion and maintaining fertility. Capability unit IVe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Crofton silt loam, 17 to 31 percent slopes, eroded (CfE2).—This soil is on narrow ridgetops and side slopes in areas that have a rough, uneven surface and on breaks along drainageways. The surface layer is grayish-brown silt loam. Many lime concretions are on the surface in most places.

Included in mapping with this soil are some severely eroded areas where the underlying loess is exposed.

This Crofton soil is better suited to grass or trees than to cultivated crops. Preventing further sheet and rill erosion, and in places gully erosion, are the main concerns of management. Capability unit VIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Gullied Land

Gullied land (GL) consists of areas along natural drainageways that are deeply cut by gullies. It is mostly in the eastern part of the county. Deep, dark alluvial soils similar to Judson silt loam, 2 to 7 percent slopes, occupied the areas before erosion, and remnants of this soil are along the gully banks. The gullies in this land type have deep, nearly vertical walls that range from 10 to 30 feet in depth and as much as 100 feet in width.

The walls consist primarily of loess, though Dakota sandstone and glacial till are exposed in places.

Included with this land in mapping are small overfalls and actively eroding gullies near the heads of drainageways. Most of these are partly stabilized by trees and shrubs. Also included are small areas of Silty alluvial land.

Gullied land is not suited to cultivation or to grazing. Structures for gully control are needed in many places. Scattered trees and shrubs are in the areas, and the land is used mainly for wildlife areas. Capability unit VIIIe-1; not suitable for range; Undesirable windbreak suitability group.

Haynie Series

The Haynie series consists of deep, nearly level, moderately well drained soils on bottom lands along the flood plain of the Missouri River. These calcareous soils formed in recent alluvium under floodwater. Because of recent river stabilization projects that include structures for flood control, the flooding hazard is now greatly diminished.

In a representative profile the surface layer is grayish-brown silt loam about 6 inches thick. The underlying material is stratified. It is grayish-brown very fine sandy loam to a depth of 18 inches. Next, to a depth of about 36 inches, is mainly light brownish-gray very fine sandy loam. Below this is light brownish-gray fine sand that is underlain at a depth below 39 inches by light brownish-gray silt loam.

The available water capacity is high in these soils. Permeability and fertility are moderate.

Haynie soils are well suited to corn, sorghum, soybeans, alfalfa, and tame grass pasture plants.

Representative profile of Haynie silt loam in a cultivated field near a riverbank (50 feet north of the center of the northwest quarter of sec. 20, T. 25 N., R. 10 E.):

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular and crumb structure; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

C1—6 to 18 inches, grayish-brown (2.5Y 5/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

IIC2—18 to 20 inches, light-gray (2.5Y 7/2) loamy fine sand, light brownish gray (2.5Y 6/2) when moist; weak, fine, platy structure; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

IIIC3—20 to 36 inches, light brownish-gray (2.5Y 6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

IVC4—36 to 39 inches, light brownish-gray (2.5Y 6/2, dry and moist) fine sand; single grain; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

VC5—39 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; abrupt, smooth boundary.

The A horizon ranges from 6 to 10 inches in thickness. Its color ranges from very dark grayish brown to grayish brown, and its texture ranges from very fine sandy loam to silt loam. The C horizon is predominantly very fine sandy loam to loam or silt loam in texture, but it contains strata of loamy sand or fine sand that vary in degree of mottling. Some soils that have clay or silty clay buried layers at a depth between 42 and 60 inches are included with these soils in mapping. Areas of Haynie soils that are adjacent to Sarpy soils contain considerable amounts of fine sand.

Haynie soils are coarser textured throughout than Albaton soils. They are finer textured than the nearby Sarpy soils.

Haynie silt loam (0 to 1 percent slopes) (He).—This is the only Haynie soil mapped in the county. It is nearly level to very gently undulating and is on the Missouri River bottom land. The individual areas are large. The surface layer is 6 to 10 inches thick, and it ranges from loam or silt loam to very fine sandy loam. A considerable amount of stratification and variation in texture occur in the subsoil and underlying material to a depth below 60 inches. This soil is very friable and is easy to work. Runoff is slow. The water table generally is at a depth below 6 feet.

Included with this soil in mapping are small areas that have a surface layer of fine sandy loam. Also included are small areas of Onawa soils.

Haynie silt loam is suited to row crops, alfalfa, and tame pasture. Maintaining fertility is the main concern of management. Capability unit I-1; Silty Lowland range site; Silty to Clayey windbreak suitability group.

Ida Series

The Ida series consists of deep, sloping to steep, well-drained, silty soils on uplands. These soils formed in silty calcareous loess. They are in the eastern part of the county.

In a representative profile the surface layer is brown silt loam about 6 inches thick. Next, at a depth between 6 and 26 inches, is very friable, pale-brown silt loam. Below this is calcareous, very friable, light yellowish-brown loess of silt loam texture.

The available water capacity is high in these soils. Permeability is moderate. Fertility is low.

These soils are suited to all crops commonly grown in the county, but the hazard of erosion is very severe if the soils are cultivated. The steep or severely eroded areas are better suited to grass or hay than to cultivated crops. The native grasses are big bluestem, little bluestem, indiangrass, switchgrass, and side-oats grama.

Representative profile of an Ida silt loam in a cultivated field (1,000 feet west and 100 feet north of the southeast corner of sec. 16, T. 24 N., R. 10 E.):

Ap—0 to 6 inches, brown (10YR 5/3) silt loam, dark brown (10YR 3/3) when moist; weak, medium and fine, granular structure; very friable; a few small lime concretions; calcareous; moderately alkaline; abrupt, smooth boundary.

C1—6 to 18 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; very friable; a few lime concretions as much as one-half inch in diameter; calcareous; moderately alkaline; clear, smooth boundary.

C2—18 to 26 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that breaks to massive; very friable; a few, fine, gray mottles; a few small lime concretions; calcareous; gradual smooth boundary.

C3—26 to 60 inches, light yellowish-brown (10YR 6/4) silt loam, yellowish brown (10YR 5/4) when moist; massive; very friable; common, fine, faint grayish and reddish-brown mottles; a few lime concretions; calcareous; moderately alkaline.

The A horizon ranges from 4 to 6 inches in thickness. Its color ranges from dark grayish brown to pale brown, depending on the degree of erosion. The C1 and C2 horizons range from yellowish brown to pale brown. Depth to the C3 horizon ranges from 12 to 26 inches, and the color of this horizon ranges from yellowish brown to very pale brown. Except that the A horizon is noncalcareous in places, the profile is calcareous.

Ida soils are near Monona soils, but they are not so well developed as those soils. They are similar to Crofton soils, but they generally contain less lime. Also, their substratum is more brown or yellowish brown.

Ida silt loam, 7 to 11 percent slopes, eroded (IdC2).—This soil has the profile described as representative of the series. It is on rounded ridgetops and convex side slopes. Runoff is medium to rapid.

Much of the original surface layer of this soil has been removed by erosion. As a result lighter colored underlying material is exposed in most places. Supplies of nitrogen and organic matter are low.

Included with this soil in mapping are small areas of Monona and Steinauer soils.

This Ida soil is suited to all crops commonly grown in the county, and most areas are cultivated. The main concerns of management are the hazard of sheet erosion, low content of organic matter, and maintaining fertility. Capability unit IVe–8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Ida silt loam, 11 to 17 percent slopes (IdD).—This soil is on sharp ridgetops and convex side slopes. Runoff is rapid, and erosion is slight. All areas are in native grass.

The surface layer is dark grayish brown and ranges from 3 to 6 inches in thickness. In many areas the profile is calcareous at or within a few inches of the surface.

This soil is suited to most of the crops grown in the county. Because of the erosion hazard, however, it is better for the areas to remain in grass than to be planted to cultivated crops. Capability unit IVe–9; Limy Upland range site; Silty to Clayey windbreak suitability group.

Ida silt loam, 11 to 17 percent slopes, eroded (IdD2).—This soil is on narrow ridgetops and convex side slopes. Runoff is rapid.

Included with this soil in mapping are small areas of Monona and Steinauer soils.

All crops commonly grown in the county can be grown on this Ida soil. The slope and severe hazard of erosion, however, make the soil better suited to grass or hay than to cultivated crops. The main concerns of management are controlling erosion and maintaining fertility. Capability unit IVe–8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Ida silt loam, 17 to 31 percent slopes (IdE).—This soil is on irregular, narrow ridgetops and side slopes. In places the steeper slopes are catstepped. Runoff is very rapid. Most areas are in native grass and trees.

The surface layer and subsoil vary widely in thickness within each mapped area because of the irregular slopes, but the profile of this soil otherwise is like that described as representative of the series.

Included with this soil in mapping are small areas of Monona soils.

This Ida soil is too steep for cultivation. It is better suited to grass and trees than to other crops. The native grasses consist primarily of big bluestem, little bluestem, side-oats grama, and switchgrass. Trees are predominantly oak and elm. Capability unit VIe-9; Limy Upland range site; Silty to Clayey windbreak suitability group.

Ida silt loam, 17 to 31 percent slopes, eroded (IdE2).—This soil is on narrow ridgetops and side slopes. Runoff is very rapid. Much of the original surface layer has been washed away, and the calcareous loess subsoil is at the surface in most places.

This soil is not suitable for cultivation. It is better suited to grass and trees than to crops. The main concerns of management are controlling sheet, rill, and gully erosion and maintaining fertility. Capability unit VIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Judson Series

The Judson series consists of deep, gently sloping, well-drained, silty soils. These soils are at the base of slopes along small upland drainageways, on foot slopes, and on valley floors along narrow streams. They formed in colluvium and alluvium that washed or rolled mainly from deep silty soils on uplands.

In a representative profile the surface layer is very dark grayish-brown to dark grayish-brown silt loam about 34 inches thick (fig. 9). It is silt loam in the upper 6 inches and silty clay loam below. The next layer, at a depth between 34 and 46 inches, is transitional between the surface layer and the underlying material. It is dark grayish-brown, very friable silty clay loam. The underlying material is silty clay loam that is brown in the upper part and pale brown in the lower part.

Available water capacity and natural fertility are high in these soils. Permeability is moderate, and runoff is medium. The supply of organic matter is good.

Judson soils are suited to all crops commonly grown in the county, and nearly all of the acreage is cultivated. They are easy to till, and they take in and release moisture readily. These soils receive additional moisture and plant nutrients from higher lying soils.

Representative profile of a Judson silt loam in a cultivated field (740 feet south and 520 feet east of the northwest corner of sec. 25, T. 26 N., R. 6 E.):

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium, subangular blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

A1—6 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, coarse, blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; medium acid; abrupt, smooth boundary.

A13—16 to 34 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky; slightly hard when dry, very friable when moist; medium acid; clear, smooth boundary.

AC—34 to 46 inches, dark grayish-brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that breaks to moderate, medium and fine, subangular blocky; hard when dry, friable when moist; thin patchy clay films; slightly acid; clear, smooth boundary.

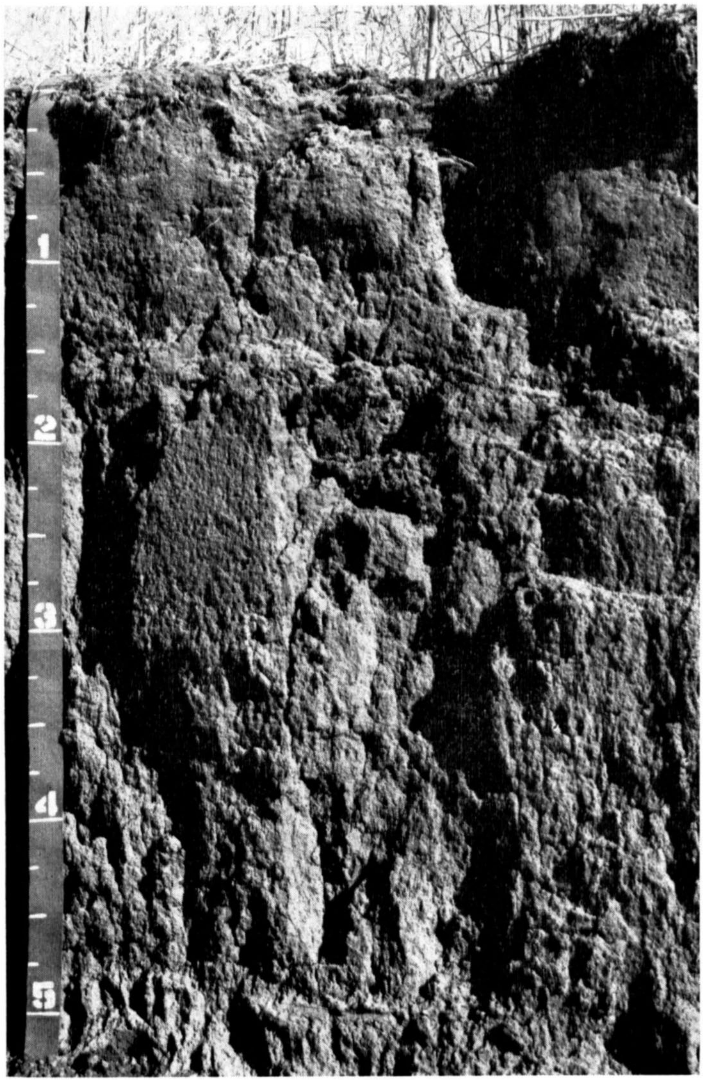

Figure 9.—**Representative profile of a Judson silt loam.**

C1—46 to 54 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; moderate, coarse and medium, prismatic structure that breaks to medium, coarse, subangular blocky; hard when dry, friable when moist; thin patchy clay films; slightly acid; clear, smooth boundary.

C2—54 to 60 inches, pale-brown (10YR 6/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, medium and fine, prismatic structure that breaks to moderate, medium and coarse, subangular blocky; slightly hard when dry, friable when moist; common, medium, distinct, dark reddish-brown mottles; neutral.

The Ap horizon ranges from black to very dark grayish-brown silt loam, loam, or light silty clay loam. Thickness of the A horizon ranges from 20 to 36 inches. These soils are noncalcareous, but in some cultivated areas the surface soil is recently deposited calcareous material. In many places a buried horizon is present. Throughout the profile, the soils range from medium acid to neutral in reaction.

Judson soils are near Moody, Monona, and Nora soils, which are on uplands on the lower part of slopes just above flood plains. Unlike those soils, Judson soils formed in deep, dark-colored colluvium and alluvium from the uplands.

Judson silt loam, 0 to 2 percent slopes (JuA).—This soil is on colluvium and alluvium adjacent to drainageways and foot slopes. Runoff is slow.

The upper 6 to 20 inches of the surface layer is friable, very dark grayish brown silt loam. In areas where this soil is associated with sandy soils, however, the surface layer contains more sand and is a loam.

Included with this soil in mapping are small areas of Judson silt loam, 2 to 7 percent slopes.

This Judson soil is suited to all crops commonly grown in the county, and most of the acreage is cultivated. It is highly fertile and is easy to work, Capability unit I–1; Silty Lowland range site; Silty to Clayey windbreak suitability group.

Judson silt loam, 2 to 7 percent slopes (JuB).—This soil has the profile described as representative of the series. It is on colluvium in concave areas between the bottom lands and the uplands. The areas generally are narrow and are at the base of slopes. They range from about 10 to 40 acres in size. Runoff is medium.

The upper 6 to 10 inches of the surface layer generally is very friable silt loam, but in places it is light silty clay loam.

This soil is suited to all crops commonly grown in the county, and most of the acreage is cultivated. It is easy to work and is highly fertile. The main concern of management is the preventing of further rill erosion and deep gullying, especially in the natural drainageways. Capability unit IIe–1; Silty range site; Silty to Clayey windbreak suitability group.

Kennebec Series

The Kennebec series consists of deep, nearly level to very gently sloping soils that are moderately well drained. These soils are on bottom lands along large upland drainageways that have entrenched channels which provide a natural drainageway for the areas. These soils formed in alluvium. They are subject to infrequent flooding. Depth to the water table is more than 6 feet.

In a representative profile the surface layer is very dark grayish-brown silt loam to a depth of 7 inches; very dark brown heavy silt loam to a depth of 20 inches; and very dark gray, friable heavy silt loam to a depth of 36 inches. Below this, to a depth of 60 inches, is friable, grayish-brown heavy silt loam.

Permeability is moderate in these soils. Available water capacity is high.

The natural vegetation on these soils was tall prairie grass. Kennebec soils are among the most fertile and easily tilled soils on bottom lands in the county.

Representative profile of Kennebec silt loam (320 feet east and 175 feet north of the southwest corner of the southeast quarter of sec. 28, T. 26 N., R. 8 E.):

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; very friable when moist, slightly sticky when wet; slightly acid; abrupt, smooth boundary.

A11—7 to 11 inches, very dark brown (10YR 2/2 dry and moist) heavy silt loam; moderate, fine, granular structure; very friable when moist, slightly sticky when wet; slightly acid; abrupt, smooth boundary.

A12—11 to 20 inches, very dark brown (10YR 2/2) heavy silt loam, black (10YR 2/1) when moist; moderate

medium, granular structure; friable when moist, sticky when wet; slightly acid; clear, smooth boundary.

A13—20 to 36 inches, very dark gray (10YR 3/1 dry and moist) heavy silt loam; moderate, fine, subangular blocky structure; friable when moist, slightly sticky when wet; neutral; clear, smooth boundary.

AC—36 to 60 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; friable when moist, slightly sticky when wet; many pores; neutral.

In places recent overwash less than 6 inches thick is on the surface of these soils. The Ap horizon ranges from very dark grayish brown to dark gray in color, and from 7 to 10 inches in thickness. Texture ranges from silt loam to very friable light silty clay loam. The A horizon below the Ap horizon generally extends to a depth of 36 inches or deeper. It ranges from very dark brown to very dark gray and from very friable to friable. Texture ranges from silt loam to light silty clay loam. The AC horizon ranges from grayish-brown to gray, friable silt loam or silty clay loam. Throughout the profile, the soils range from slightly acid to neutral.

Kennebec soils are near Colo and Lamo soils along drainageways on uplands. They are better drained than those soils and are not so fine textured.

Kennebec silt loam (0 to 1 percent slopes) (Ke).—This is the only Kennebec soil mapped in the county. It is along entrenched major streams and drainageways throughout the uplands. Flooding is infrequent in most areas, and runoff is slow. Individual areas range up to 50 or 60 acres in size. The surface layer ranges from friable to very friable silt loam to light silty clay loam. The underlying material ranges from friable heavy silt loam to light silty clay loam.

Included with this soil in mapping are small areas of Colo silty clay loam.

This Kennebec soil is suited to all crops commonly grown in the county, but corn, grain sorghum, and soybeans are better suited than other crops. The main concern of management is maintaining a balance between fertility and moisture. Capability unit I–1; Silty Lowland range site; Silty to Clayey windbreak suitability group.

Lamo Series

The Lamo series consists of deep, nearly level, somewhat poorly drained soils along upland drainageways throughout the county. These soils formed in alluvium laid down by streams. Depth to the water table is about 5 feet.

In a representative profile the surface layer is very dark gray to black silty clay loam about 35 inches thick. The next layer, at a depth between 35 and 60 inches, is dark-gray silty clay loam. It is very friable and is strongly calcareous. At a depth below 60 inches is light brownish-gray sandy clay loam.

The available water capacity is high in these soils. Runoff is slow. Permeability is moderately slow. These soils are subject to occasional flooding, generally in spring.

Lamo soils are mostly in bluegrass pastures, but they are well suited to corn, soybeans, and alfalfa. Prairie cordgrass grows in the wetter areas. The natural vegetation on these soils was tall prairie grasses.

Representative profile of Lamo silty clay loam in a cultivated field (182 feet east and 90 feet south of the northwest corner of sec. 1, T. 26 N., R. 5 E.):

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, medium and fine, subangular blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; slightly calcareous; moderately alkaline; abrupt, smooth boundary.

A11—7 to 17 inches, black (10YR 2/1 dry and moist) silty clay loam; weak, coarse, prismatic structure that breaks to weak, coarse, subangular blocky; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; gradual, smooth boundary.

A12—17 to 35 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, coarse, prismatic structure that breaks to moderate, coarse and medium, subangular blocky; soft when dry, very friable when moist; strongly calcareous; moderately alkaline; gradual, smooth boundary.

AC—35 to 54 inches, dark-gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, coarse and medium, prismatic structure that breaks to moderate, medium, subangular blocky; soft when dry, very friable when moist; many fine pores; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C1g—54 to 60 inches, dark-gray (2.5Y N 4/0) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium and fine, subangular blocky; soft when dry, very friable when moist; a few, soft, segregated lime particles one-fourth inch thick; a few, fine, distinct strong-brown mottles; strongly calcareous; moderately alkaline; gradual, smooth boundary.

C2g—60 to 72 inches, light brownish-gray (2.5Y 6/2) sandy clay loam, dark gray (10YR 4/1) when moist; soft when dry, very friable when moist, plastic when wet; common, fine, distinct dark reddish-brown mottles; strongly calcareous; strongly alkaline.

The A horizon ranges from black to dark gray and is predominately silty clay loam. In places subject to frequent flooding, the surface and subsurface horizons are stratified silt loam and silty clay loam. Here the surface horizon is noncalcareous in places. The AC and C horizons are predominantly silty clay loam, but in places they include a thin horizon of light silty clay. In many areas lime concretions occur in the AC and lower horizons. Lamo soils that occur in the transitional area between sand and loess generally are sandy clay loam in the lower part of the C horizon. The Lamo soils derived mainly from loess soils on uplands have silty clay loam in the lower horizons.

Lamo soils are near the noncalcareous Colo and Kennebec soils. They are not so well drained as Kennebec soils.

Lamo silt loam, overwash (0 to 1 percent slopes) (2La).—This soil is on bottom lands that are subject to occasional flooding. It has a surface layer of overwash, but its profile otherwise is similar to that described as representative of the series.

The surface layer is dark gray to very dark brown, calcareous silt loam that ranges from 6 to 20 inches in thickness. In some areas the surface layer is stratified with light silty clay loam. The next layer is very dark gray to dark-gray silty clay loam about 36 inches thick. In places the surface layer is noncalcareous. Depth to the water table ranges from 6 to 8 feet. Wetness normally is not a problem, though runoff is slow.

Included with this soil in mapping are small areas of Colo soils.

Most of the acreage of this Lamo soil is cultivated, but because of the flooding hazard, many areas remain in pasture. This soil is well suited to corn, soybeans, or sorghum. These crops grow well in seasons when flooding is limited or no flooding occurs. Capability unit IIw–3; Silty Overflow range site; Moderately Wet windbreak suitability group.

Lamo silty clay loam (0 to 1 percent slopes) (Lb).—This soil has the profile described as representative of the series. It is on bottom lands along streams and major drainageways in the uplands. Runoff generally is slow.

In places 2 to 6 inches of light-colored calcareous silt loam has been laid down on the surface of this soil by floodwater. Below the surface layer is a layer of silty clay loam, about 30 inches thick, that has a variable amount of mottles.

Included with this soil in mapping are small areas of Colo soils and small areas of soil that has a surface layer of silt loam and a subsoil of light silty clay. Also included are small areas of Wet alluvial land shown on the detailed map by a spot symbol.

Most of this Lamo soil is in bluegrass pasture. Prairie cordgrass grows in the wet areas. Cultivated crops on this soil obtain some moisture from the water table, but uneven stands are common because excessive wetness delays planting in some seasons. This soil is well suited to corn and soybeans, but it is better suited to pasture unless adequately drained. Capability unit IIw-4; Subirrigated range site; Moderately Wet windbreak suitability group.

Luton Series

The Luton series consists of deep, nearly level, poorly drained soils on bottom lands. These soils formed in clayey sediment laid down in slackwater areas. The water table is at a depth of about 6 feet.

In a representative profile the surface layer is black silty clay about 19 inches thick. The subsoil is dark-gray, firm silty clay about 21 inches thick. It is calcareous and has a few red mottles. The underlying material is grayish-brown, calcareous silty clay.

Available water capacity is high in these soils. Permeability is slow. Fertility and content of organic matter are high.

Luton soils are suited to all crops commonly grown in the county, and most areas are cultivated. They are better suited to corn and soybeans, however, than to other crops. Fine texture and slow internal drainage are the main limitations.

Representative profile of Luton silty clay in a cultivated field (0.5 mile south and 50 feet west of the northeast corner of sec. 28, T. 24 N., R. 8 E.):

Ap—0 to 6 inches, black (10YR 2/1 dry and moist) silty clay; moderate, medium and fine, subangular blocky structure that breaks to weak, medium and fine, granular; hard when dry, firm when moist; mildly alkaline; abrupt boundary.

A11—6 to 11 inches, black (10YR 2/1 dry and moist) silty clay, moderate to strong, medium and fine, angular blocky structure; very hard when dry, firm when moist; mildy alkaline; abrupt, smooth boundary.

A12—11 to 19 inches, black (2.5Y N 2/0) silty clay, black (10YR 2/1) when moist; moderate, medium and fine, blocky structure that breaks to moderate, medium and fine, subangular blocky; very hard when dry, firm when moist; mildly alkaline; clear, smooth boundary.

B2g—19 to 40 inches, dark-gray (2.5Y N 4/0) silty clay, very dark gray (2.5Y N 3/0) when moist; a few, fine, faint, red mottles; strong, coarse and medium, blocky structure that breaks to strong, medium, angular blocky; very hard when dry, firm when moist; calcareous; moderately alkaline; clear, smooth boundary.

Cg—40 to 60 inches, grayish-brown (2.5Y 5/2) silty clay, dark gray (10YR 4/1) when moist; common, medium, distinct, dark-brown mottles; strong, coarse and medium, blocky structure that breaks to strong, medium, subangular blocky; very hard when dry, firm when moist; calcareous; strongly alkaline.

The A horizon ranges from silty clay loam to clay, and the B horizon, from silty clay to clay. Depth to mottles ranges from 16 to 36 inches, and intensity of mottling ranges from faint to prominent. Depth to lime accumulation ranges from 24 to 40 inches.

Luton silty clay loam (0 to 1 percent slopes) (Ls).—This soil is on flood plains of the principal streams in the county. Runoff is slow.

The surface layer ranges from black to very dark brown silty clay loam. It is firm when moist. The subsoil is similar to that in the profile described as representative of the series.

Included with this soil in mapping are small areas of Colo soils.

This Luton soil is suited to all crops commonly grown in the county. The surface layer is easier to till and can be cultivated within a wider range of moisture content than that of Luton silty clay. The main concerns of management are poor drainage and maintaining a balance between fertility and moisture. Capability unit IIIw-2; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Luton silty clay (0 to 1 percent slopes) (Lk).—This soil has the profile described as representative of the series. It is along the flood plains of large streams in the county. Runoff is slow.

Included with this soil in mapping are small areas of alkali soils. Crops on these included soils are likely to be damaged somewhat.

Drainage has been established on this soil, and all areas are cultivated. Water ponds in places because of very slow internal drainage. As a result, planting is delayed or the crops are drowned out in some seasons. Considerable power is required to till this soil. Fall plowing helps the soils to dry out in spring and permits earlier planting. All row crops commonly grown in the county are grown on this soil, though it is better suited to corn and soybeans than to other crops. The main concerns of management are the heavy texture of the soil and poor drainage. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Marsh

Marsh (M) consists of wet areas along the Missouri River. These areas are periodically flooded. The vegetation is chiefly willow trees, aquatic plants, and grasslike plants. The areas are 1 to 3 feet above the normal level of the river channel. They formerly were a part of the river channel, but stabilization work has diverted the channels from these low-lying areas.

Marsh provides excellent areas for wildlife habitat. Capability unit VIIIw-1; not used as range; Undesirable windbreak suitability group.

McPaul Series

The McPaul series consists of deep, silty, well-drained soils. These nearly level soils formed in alluvium. Some of the areas are along streams in the uplands. Others are on fans on bottom lands along rivers where light-colored silty material washed from the uplands covers medium-textured soils. The largest areas are at the heads of drainageways below eroded silty upland soils.

In a representative profile the surface layer is calcare-

ous, dark grayish-brown silt loam about 7 inches thick. Below this is very friable, calcareous, grayish-brown silt loam to a depth of about 30 inches. This material is highly stratified and in places contains lime concretions washed in from other areas. A buried soil of very dark gray silty clay loam is at a depth below 30 inches.

McPaul soils are subject to occasional flooding, but they are forming under good drainage. The available water capacity is high, and permeability is moderate. Runoff is slow. Fertility is high in these soils, and lime is plentiful.

In areas where measures have been applied to reduce the wash from higher lying soils on uplands, organic matter is accumulating in the McPaul soils. The organic matter is making the soils in such areas darker colored.

McPaul soils are well suited to corn, sorghum, and soybeans. The most serious hazard on these soils is flooding, which sometimes causes crop losses.

Representative profile of McPaul silt loam in a cultivated field (175 feet north and 50 feet west of the southeast corner of sec. 6, T. 26 N, R. 7 E.):

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and fine, granular structure; soft when dry, friable when moist; calcareous; moderately alkaline; abrupt, smooth boundary.

C1—7 to 10 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, coarse and medium, subangular blocky structure that breaks to weak, fine, granular; slightly hard when dry, very friable when moist; calcareous; moderately alkaline; abrupt, smooth boundary.

C2—10 to 30 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure that breaks to weak, very fine, granular; soft when dry, very friable when moist; calcareous; moderately alkaline; clear, smooth boundary.

A1b—30 to 53 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, medium and fine, granular and crumb structure; soft when dry very friable when moist; noncalcareous; moderately alkaline.

The A horizon ranges from 6 to 9 inches in thickness. In places recently deposited grayish-brown material that is low in content of organic matter is on the surface. The soil profile generally is highly stratified. The strata are darker and lighter colored than the A horizon. An A1b horizon, a buried dark-colored surface soil, is common at a depth between 24 and 50 inches. This horizon ranges from light silty clay loam to silt loam and is calcareous in the lower part.

McPaul soils are near Colo, Judson, and Lamo soils. They are lighter colored and siltier than Colo or Judson soils and are better drained than Colo and Lamo soils.

McPaul silt loam (0 to 1 percent slopes) (Mc).—This is the only McPaul soil mapped in the county. It is along streams and along some upland drainageways. Runoff is slow. Each time the streams overflow, new sediment generally is added. The sediment consists mostly of material washed from upland soils. In many places the formation of this soil and its boundaries has been determined by roads and fencerows that help stop the stream sediment in which the soil is forming. The surface layer is friable and takes in water readily. The subsoil ranges from silt loam to light silty clay loam and generally is highly stratified. Included with this soil in mapping are small areas of Lamo silt loam, overwash, and of Kennebec silt loam.

This McPaul soil is well suited to corn, sorghum, and soybeans. The main concerns of management are preventing flooding and maintaining fertility. Capability unit IIw-3; Silty Overflow range site; Moderately Wet windbreak suitability group.

Monona Series

The Monona series consists of deep, well-drained, gently sloping to steep soils on ridgetops and side slopes. These soils formed under mid and tall grasses in silty loess (fig. 10). They are in the eastern part of the county, commonly in the area referred to as the Missouri River Bluff Zone.

In a representative profile the surface layer is silt loam about 12 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The subsoil is very friable, brown silt loam about 18 inches thick. The underlying material is very friable, pale-brown silt loam loess that is limy in the lower part.

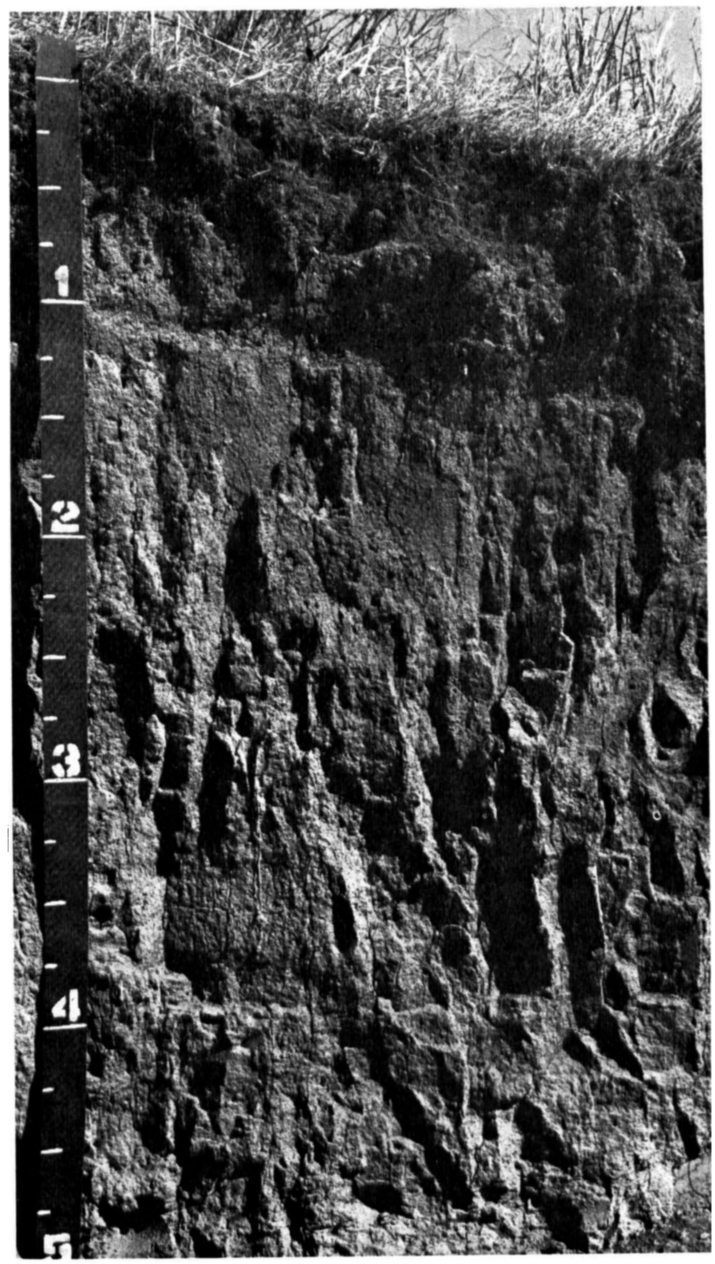

Figure 10.—Profile of a Monona silt loam.

Available water capacity and natural fertility are high in these soils. Permeability is moderate.

Monona soils are suited to all crops commonly grown in the county. Except for some areas on the steeper slopes, nearly all areas are cultivated. The main concern of management is preventing further erosion if these soils are tilled.

Representative profile of a Monona silt loam in a cultivated field (1,020 feet west and 600 feet south of the northeast corner of the southeast quarter of sec. 32, T. 27 N, R. 9 E.):

Ap—0 to 6 inches, very dark grayish-brown (19YR 3/2) silt loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

A1—6 to 12 inches, dark grayish-brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, granular; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

B21—12 to 17 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that breaks to medium, subangular blocky; soft when dry, very friable when moist; neutral; clear, smooth boundary.

B22—17 to 30 inches, brown (10YR 5/3) silt loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, coarse and moderate, subangular blocky; soft when dry, very friable when moist; neutral; clear, smooth boundary.

C1—30 to 42 inches, pale-brown (10YR 6/3) silt loam, brown (10YR 5/3) when moist; weak, medium and fine, subangular blocky structure; soft when dry, very friable when moist; mildly alkaline; clear, smooth boundary.

C2—42 to 60 inches, pale-brown (10YR 6/3) silt loam; brown (10YR 5/3) when moist; massive; soft when dry, very friable when moist; slightly calcareous; moderately alkaline.

The A horizon ranges from very dark brown or brown in eroded areas to very dark grayish brown in slightly eroded areas. The B horizon ranges from dark grayish brown to brown. It ranges from 12 to 24 inches in thickness and from silt loam to light silty clay loam in texture. Depth to lime ranges from 20 to 40 inches in the moderately steep to steep areas. In places lime concretions are in the profile. In nearly level to gently sloping areas, the lime is leached to a depth below 40 inches, and the lime is in disseminated form.

Monona soils are near Ida soils, but they are leached of lime to a greater depth than those soils. Their subsoil is more friable and less clayey than that in Moody soils and is less well developed.

Monona silt loam, 1 to 7 percent slopes (MnB).—This soil is predominantly on smooth, convex ridgetops under grass or trees. Runoff is slow to medium, and little or no erosion has occurred. The areas generally are large.

The surface layer is very friable, very dark grayish-brown silt loam that ranges from 10 to 14 inches in thickness. The subsoil is silt loam about 24 inches thick. Depth to lime generally is more than 60 inches.

Included with this soil in mapping are small areas of Ida soils.

This Monona soil takes in water readily. Permeability is moderate, and fertility is high.

All crops commonly grown in the county are suited. The main concerns of management are controlling erosion and maintaining fertility. Capability unit IIe-1; Silty range site; and Silty to Clayey windbreak suitability group.

Monona silt loam, 1 to 7 percent slopes, eroded (MnB2).—This soil is on broad slightly convex upland divides. Runoff is slow to medium.

The surface layer is friable, very dark-brown silt loam about 6 inches thick. The subsoil is about 24 inches thick and is slightly finer textured than the surface layer. Lime is at a depth between 40 and 60 inches.

Included with this soil in mapping are small areas of uneroded Monona soils. Also included are small severely eroded areas shown on the detailed map by a spot symbol.

This Monona soil is suited to all crops commonly grown in the county, and all areas are cultivated. The main concerns of management are preventing further erosion and maintaining fertility. Capability unit IIIe-8; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 7 to 11 percent slopes (MnC).—This sloping soil is chiefly on lower concave slopes along small drainageways in the uplands. Runoff is medium, and little or no erosion has occurred.

The surface layer is very dark grayish-brown silt loam and ranges from 8 to 12 inches in thickness. Thickness of the surface layer varies according to the position on the slope. Thickness of the subsoil ranges from 18 to 24 inches. Depth to lime ranges from 24 to 40 inches.

Included with this soil in mapping are small areas of a Judson silt loam and of an Ida silt loam. Also included are severely eroded areas shown on the detailed map by a spot symbol.

This Monona soil is in good tilth and is easy to work. It is suited to all crops commonly grown in the county. The main concerns of management are preventing erosion and maintaining a balance between fertility and moisture. Capability unit IIIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 7 to 11 percent slopes, eroded (MnC2).—This soil generally is on the upper part of side slopes, where runoff is rapid. The surface layer is very friable, dark-brown silt loam about 6 inches thick that rests abruptly upon the subsoil. It is lower in organic matter and is not so fertile as the uneroded Monona soils. The subsoil ranges from 15 to 24 inches in thickness. Lime generally is at a depth between 24 and 36 inches.

Included with this soil in mapping are small areas of Ida silt loam and of Monona silt loam on slopes of 7 to 11 percent.

This Monona soil is well suited to all crops commonly grown in the county. The main concerns of management are preventing further erosion and maintaining fertility. Capability unit IIIe-8; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 11 to 17 percent slopes (MnD).—This soil has the profile described as representative of the series. It occupies low positions and has slightly concave slopes. Runoff is rapid, and this soil is slightly eroded to moderately eroded. The areas generally are below steep Monona and Ida soils. Variations are mainly in thickness of the surface layer. This layer is 9 to 14 inches thick.

Included with this soil in mapping are small areas of Monona silt loam, 7 to 11 percent slopes; Monona silt loam, 11 to 17 percent slopes, eroded; and Ida silt loam, 11 to 17 percent slopes, eroded.

This Monona soil is suited to nearly all crops commonly grown in the county. The slopes and severe erosion hazard make this soil better suited to grass and hay

crops, which help to control erosion, than to cultivated crops. The main concerns of management are the steep slopes, controlling erosion, and maintaining fertility. Capability unit IVe-1; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 11 to 17 percent slopes, eroded (MnD2).—This soil generally is on the upper part of slightly convex slopes, where runoff is rapid. The areas are irregular in shape and small in size.

The surface layer is about 6 inches thick. The subsoil ranges from 12 to 42 inches in thickness. Lime is at a depth between 20 and 42 inches. The content of organic matter and of available nitrogen are low.

Included with this soil in mapping are small areas of Monona silt loam, 11 to 17 percent slopes, and of Ida silt loam, 11 to 17 percent slopes, eroded.

This Monona soil is well suited to grass and hay crops. The main concerns of management are the slopes, the severe hazard of further erosion, and the highly erodible surface soil and subsoil. Erosion is difficult to control if row crops are grown year after year. Establishing native grasses is the most suitable method for controlling erosion. Capability unit IVe-8; Silty range site; Silty to Clayey windbreak suitability group.

Monona silt loam, 17 to 31 percent slopes (MnF).—This soil is mostly on side slopes that face east. The areas generally are below a ridge of Ida soils. Runoff is very rapid, and erosion is slight to severe.

The surface layer is dark grayish brown to brown silt loam. It ranges from 5 to 10 inches in thickness, depending on the degree of erosion and the position of the soil on the slope. The subsoil ranges from 12 to 20 inches in thickness. Depth to lime ranges from 20 to 60 inches.

Included with this soil in mapping are small areas of Ida soils on the shoulders of slopes and the points of ridges.

This Monona soil is not suited to cultivated crops. It is suited to permanent grass or trees. Capability unit VIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Moody Series

The Moody series consists of deep, nearly level to sloping, well-drained soils. These soils formed in loess on uplands and on stream terraces.

In a representative profile the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 34 inches thick. It is dark brown in the upper part and brown in the lower part. It is friable silty clay loam throughout. The underlying material is yellowish-brown silty clay loam in the upper part and very pale brown silt loam in the lower part.

These soils take in moisture readily. The available moisture capacity and natural fertility are high. Permeability is moderately slow.

Most areas of Moody soils are cultivated, and all crops commonly grown are suited. Erosion is a hazard in the sloping areas, and practices are needed for controlling erosion.

Representative profile of a Moody silty clay loam in a cultivated field (50 feet west and 1,848 feet south of the northeast corner of sec. 29, T. 26 N., R. 6 E.):

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular and crumb structure; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

A1—6 to 9 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; slightly acid; clear, smooth boundary.

B1—9 to 16 inches, dark-brown (10YR 3/3) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse and medium, subangular blocky structure that breaks to weak, medium and fine, subangular blocky; soft when dry, friable when moist; neutral; clear, smooth boundary.

B2—16 to 33 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; moderate, coarse, prismatic structure that breaks to moderate, coarse and medium, subangular blocky; slightly hard when dry, friable when moist; thin, continuous clay films on all horizontal ped faces and a few on vertical ped faces; neutral; clear, smooth boundary.

B3—33 to 43 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to weak, medium and fine, subangular blocky; slightly hard when dry, friable when moist; a few, medium, distinct, reddish-brown mottles; thin, continuous clay films on horizontal ped faces; neutral; clear, smooth boundary.

C1—43 to 54 inches, yellowish-brown (10YR 5/4) silty clay loam, brown (10YR 5/3) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, subangular blocky; soft when dry, very friable when moist; common, medium, distinct, reddish-brown mottles; neutral; clear, smooth boundary.

C2—54 to 70 inches, very pale brown (10YR 7/4) silt loam, yellowish brown (10YR 5/4) when moist; massive; soft when dry, very friable when moist; many, medium, distinct, reddish-brown mottles; slightly calcareous; mildly alkaline; gradual, wavy boundary.

C3ca—70 to 80 inches, very pale brown (10YR 7/4) silt loam, light yellowish brown (10YR 6/4) when moist; massive; soft when dry, very friable when moist; many, medium, distinct, reddish-brown mottles; strongly calcareous; moderately alkaline.

The A horizon ranges from very dark brown to dark grayish brown or very dark grayish brown in color and from silty clay loam and silt loam or loam to fine sandy loam in texture. The B horizon is light silty clay loam in areas east of Logan Creek and finer textured silty clay loam west of this creek. It ranges from 24 to 42 inches in thickness. Thin, patchy to moderate, continuous clay films are on vertical structural surfaces and in places on horizontal surfaces. Depth to calcium carbonate concretions is between 30 and 42 inches in sloping areas and between 42 and 60 inches in nearly level areas.

Moody soils are near Nora and Crofton soils. They have a thicker subsoil than Nora soils, and depth to lime is greater than in Nora and Crofton soils. Their A horizon is thinner than that of Judson soils on adjoining colluvial slopes.

Moody silty clay loam, 0 to 1 percent slopes (Mo).—This soil is on uplands. The areas are irregular in shape and range from a few acres to 40 acres. The average slope is 1 percent. Runoff generally is slow to medium.

The surface layer is friable silty clay loam that ranges from 10 to 16 inches in thickness. The subsoil, about 42 inches thick, is slightly more compact and contains more clay than that in the profile described as representative of the series. It also has lime at a greater depth.

Included with this soil in mapping are small areas of Belfore soils. Also included are small swales or depressional areas.

This Moody soil is suited to all crops commonly grown in the county, and nearly all of it is cultivated. It is easy to work. If this soil is cultivated, maintaining fertility and good tilth are the main concerns of management. In places lime is needed to establish legumes. Capability unit I-1,

Silty range site; Silty to Clayey windbreak suitability group.

Moody silty clay loam, 1 to 7 percent slopes (MoB).—This soil has the profile described as representative of the series. It is on smooth, very slightly convex ridgetops and slopes. Runoff is medium, and the soil is slightly eroded.

The surface layer is very dark grayish-brown silty clay loam 7 to 14 inches thick. Above the calcareous subsoil the profile is slightly acid to neutral in reaction. Depth to lime ranges from 40 to 60 inches.

Included with this soil in mapping are small areas of Belfore soil that are less sloping than this Moody soil.

This Moody soil is suited to all crops commonly grown in the county. The main concerns of management are controlling losses of soil and moisture and maintaining fertility. In places lime is needed to establish legumes. Capability unit IIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Moody silty clay loam, 1 to 7 percent slopes, eroded (MoB2).—This soil is on smooth convex ridgetops and side slopes. The largest areas generally are on narrow divides that have an average slope of 5 percent. Runoff is medium, and this soil is moderately eroded to severely eroded.

The surface layer is very dark grayish-brown to dark grayish-brown, friable silty clay loam about 7 inches thick. The plow layer rests directly on the upper part of the subsoil, and material formerly in the upper part of the subsoil has been mixed with the remaining surface layer by plowing. Erosion has made the present surface layer slightly more clayey than that in the uneroded soils. Depth to lime ranges from 36 to 48 inches.

Included with this soil in mapping are small areas of Crofton and Nora soils.

This Moody soil is suited to all crops commonly grown in the county. Practices that control erosion are needed to reduce losses of soil and moisture. Capability unit IIIe-8; Silty range site; Silty to Clayey windbreak suitability group.

Moody silty clay loam, 7 to 11 percent slopes (MoC).—This soil is in narrow areas along small drainageways. The average slope is 8 percent. Runoff is medium to rapid.

The surface layer of this soil is very dark brown to very dark grayish-brown silty clay loam that ranges from 7 to 12 inches in thickness. Depth to lime ranges from 38 to 60 inches.

Included with this soil in mapping are small areas of Crofton and Nora soils on slightly convex areas and on points of hills. Also included are small areas of Judson soils on short side slopes along drainageways.

This Moody soil is suited to all crops commonly grown in the county. The main concerns of management are the slopes and hazard of severe erosion and maintaining fertility. Practices are needed that reduce losses of soil and moisture (fig. 11). Capability unit IIIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Moody silty clay loam, 7 to 11 percent slopes, eroded (MoC2).—This soil is on slightly convex slopes. The average slope is about 10 percent, and runoff is rapid.

In this soil plowing has mixed material formerly in the subsoil with the remaining surface layer. Except that it is not quite so thick, the subsoil is similar to that in the profile described as representative of the series. Depth to lime ranges from 30 to 50 inches.

Included with this soil in mapping are small areas of Crofton and Nora soils.

Figure 11.—**Terraces and stripcropping on Moody silty clay loam, 7 to 11 percent slopes, help to control erosion.**

This Moody soil is suited to all crops commonly grown in the county, and all of the acreage is cultivated. The main concerns of management are controlling erosion, preventing loss of moisture, and maintaining fertility. Capability unit IIIe-8; Silty range site; Silty to Clayey windbreak suitability group.

Moody fine sandy loam, 7 to 11 percent slopes (MyC).—This soil is on hillsides in areas of loess that have a thin mantle of sand. The areas are small and irregular in shape. Runoff is medium, and erosion is slight to none.

The surface layer is dark grayish-brown fine sandy loam that ranges from 6 to 14 inches in thickness. The subsoil is silty clay loam about 36 inches thick.

Included with this soil in mapping are small areas that have a surface layer of loam.

This Moody soil is well suited to all crops commonly grown in the county. Soil blowing and water erosion are the main concerns of management. Capability unit IIIe-3; Sandy range site; Sandy windbreak suitability group.

Nora Series

The Nora series consists of gently sloping to steep, well-drained soils on uplands. These soils formed in thick deposits of Peoria loess under tall prairie grass. They are on ridgetops and convex areas in the western two-thirds of the county. The profile is weakly developed.

In a representative profile the surface layer in uneroded areas is dark-gray silt loam about 12 inches thick. The subsoil is 24 inches thick. It is very friable brown silty clay loam in the upper part and light brownish-gray silt loam in the lower part, which is calcareous. The underlying material is strongly calcareous, light brownish-gray silt loam.

The available water capacity is high in these soils. Permeability is moderate. In uneroded areas fertility is moderate. In eroded areas the content of organic matter and the supplies of nitrogen and available phosphorus are low. Excessive amounts of lime in severely eroded areas reduce the availability of phosphorus.

Nora soils are well suited to all crops commonly grown in the county. If these soils are cultivated and measures for conserving soil and moisture are not applied, the hazard of water erosion is severe.

Representative profile of a Nora silt loam under native grass (1,450 feet west and 300 feet north of the southeast corner of sec. 9, T. 26 N., R. 7 E.):

A11—0 to 10 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, medium and fine,

granular structure; soft when dry, very friable when moist; neutral; clear, smooth boundary.

A12—10 to 12 inches, dark-gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, subangular blocky; slightly hard when dry, very friable when moist; neutral; clear, smooth boundary.

B21—12 to 21 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, medium, prismatic structure that breaks to weak, medium and fine, subangular blocky; slightly hard when dry, very friable when moist; mildly alkaline; clear, smooth boundary.

B22ca—21 to 25 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 4/3) when moist; weak, coarse, subangular blocky structure that breaks to weak, medium and fine, subangular blocky; slightly hard when dry, very friable when moist; strongly calcareous; moderately alkaline; many lime concretions one-fourth inch in diameter; gradual, smooth boundary.

B3ca—25 to 36 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) when moist; weak, medium to fine, subangular blocky structure; slightly hard when dry, very friable when moist; a few, fine, faint, yellowish-brown mottles; strongly calcareous; strongly alkaline; lime concretions one-fourth inch in diameter; gradual, smooth boundary.

C—36 to 60 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) when moist; massive; soft when dry, very friable when moist; a few, fine, faint, yellowish-brown mottles; strongly calcareous; strongly alkaline; lime concretions one-fourth inch in diameter.

The A horizon ranges from dark gray, very dark grayish brown, or very dark brown in uneroded areas to grayish brown, brown, or dark yellowish brown in eroded areas. It ranges from 6 to 15 inches in thickness. Slope and erosion vary. The texture is dominantly silt loam in areas under native grass and silt loam or light silty clay loam in areas cultivated or eroded.

The B horizon ranges from dark brown or brown to light brownish gray in color, and ranges from light silty clay loam to silty loam in texture. Thin patchy clay films are on the vertical faces of some of the subangular blocky peds. Depth to lime ranges from 10 to 30 inches in uneroded areas and is extremely variable within short horizontal distances. In eroded areas the surface layer is limy and is neutral to mildly alkaline.

The C horizon is silty loess. It ranges from light gray to light yellowish brown and generally is mottled with yellowish brown or dark brown. It is moderately calcareous to strongly calcareous.

Nora soils are near Crofton and Moody soils. They have a thicker subsoil than Crofton soils and are deeper to lime. Nora soils have a thinner subsoil than Moody soils and are not so deep to lime as those soils.

Nora silt loam, 1 to 7 percent slopes, eroded (NoB2).—This soil is on ridgetops and short, convex side slopes. Runoff is medium, and this soil is moderately eroded to severely eroded.

The surface layer ranges from very dark brown to dark yellowish-brown silt loam and is about 6 inches thick. It is very friable and is easy to work, but it is low in organic matter. The plow layer lies directly on the subsoil. In the severely eroded areas, material from the subsoil has been mixed with the remaining surface layer by plowing and the plow layer is lighter colored than that in less eroded areas. Depth to lime generally ranges from 6 to 20 inches, but lime is at the surface in places.

Included with this soil in mapping are small areas of Moody silty clay loam, 1 to 7 percent slopes, eroded. Also included are small areas of Crofton silt loam, 1 to 7 percent slopes, eroded.

This Nora soil is suited to all crops commonly grown in the county, and nearly all of it is cultivated. The main concerns of management are the hazard of erosion and the need to maintain a balance between fertility and moisture. Capability unit IIIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Nora silt loam, 7 to 11 percent slopes (NoC).—This soil has the profile described as representative of the series. It has concave slopes. Runoff is medium to rapid, and the soil is slightly eroded to moderately eroded. The areas are small and irregular in shape.

The surface layer of this soil is dark-gray silt loam 8 to 12 inches thick. The subsoil is 20 to 24 inches thick. Depth to lime ranges between 10 and 30 inches.

Included with this soil in mapping are small areas of Crofton silt loam in convex areas and other small areas. Also included are small areas of Nora soils that have a surface layer of loam or fine sandy loam and are adjacent to sandy soils.

This Nora soil is suited to all crops commonly grown in the county. Controlling erosion and maintaining fertility are the chief concerns of management. Capability unit IIIe-1; Silty range site; Silty to Clayey windbreak suitability group.

Nora silt loam, 7 to 11 percent slopes, eroded (NoC2).—This soil is on short, convex ridgetops and side slopes. Runoff is rapid, and erosion is moderate to severe.

The surface layer is brown or dark-brown silt loam about 6 inches thick and rests directly upon the subsoil. The subsoil ranges from 6 to 15 inches in thickness. Depth to lime ranges from 6 to 24 inches, and in many places the soil is calcareous at the surface. In the more eroded areas the lighter colored subsoil and underlying material are exposed.

Included with this soil in mapping are small areas of Nora silt loam, 7 to 11 percent slopes, and small areas of Nora soils that have a surface layer of fine sandy loam. Also included are small areas of Moody silty clay loam, 7 to 11 percent slopes, along the lower slopes.

This Nora soil is suited to all crops commonly grown in the county. The main concerns of management are maintaining fertility and controlling erosion, which lowers the intake rate, increases runoff, and reduces fertility. Capability unit IIIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Nora silt loam, 11 to 17 percent slopes (NoD).—In most areas of this soil, slopes are slightly concave. Runoff is rapid to very rapid.

The thickness of the horizons is highly variable, but the profile of this soil otherwise is similar to that described as representative of the series. The surface layer is dark-brown silt loam and ranges from 6 to 14 inches in thickness. The subsoil ranges from 6 to 20 inches in thickness. Depth to lime normally ranges from 10 to 24 inches.

Included with this soil in mapping are small areas of Crofton soils on the shoulders and points of hills. Also included are small areas of Moody soils at the base of slopes.

This Nora soil is suited to most crops commonly grown in the county, but the slope and erosion hazard limit use of row crops. The main concern of management is controlling sheet and rill erosion. Capability unit IVe-1; Silty range site; Silty to Clayey windbreak suitability group.

Nora silt loam, 11 to 17 percent slopes, eroded (NoD2).—Most of the original surface layer of this soil has been washed away. The present surface layer is less than 6 inches thick. It ranges from silt loam to light silty clay loam in texture. The subsoil ranges from 6 to

12 inches in thickness. Lime generally occurs at a depth of 6 to 15 inches, but in many places it is on the surface. Runoff is rapid to very rapid on this soil.

This soil is suited to most crops commonly grown in the county. Row crops generally are grown less than other crops because the hazard of further erosion is severe. Also erosion has lowered the content of organic matter and reduced fertility. Capability unit IVe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Nora silt loam, 17 to 31 percent slopes, eroded (NoE2).—This steep soil has a surface layer of brown or dark yellowish-brown silt loam or light silty clay loam. The color and texture vary with the degree of erosion. Lime generally is at a depth between 6 and 15 inches, but it is on the surface in some places. Runoff is very rapid.

Included with this soil in mapping, and making up as much as 15 percent of the mapped areas, are small areas of Crofton soils.

Most of this Nora soil has been cultivated at some time, but much of the acreage has been returned to grass. This soil is better suited to native grass than to cultivated crops. The main concerns of management are the steep slopes, the hazard of further severe erosion, and maintaining fertility. Capability unit VIe-8; Limy Upland range site; Silty to Clayey windbreak suitability group.

Onawa Series

The Onawa soils consist of nearly level, poorly drained, calcareous soils on bottom lands along the Missouri River. These soils formed in sediment laid down by the Missouri River. The sediment is about 18 inches thick and overlies coarser textured material that is predominantly very fine sandy loam. The sediment consists of two parts. The upper part is made up of stratified silty clay that has been in place long enough for some organic matter to accumulate. The lower part is very fine sandy loam that contains thin layers of fine sand.

In a representative profile the surface layer is calcareous, grayish-brown silty clay about 6 inches thick that is firm when moist. The next layer is olive-gray firm silty clay 6 to 18 inches thick. Between a depth of 18 and 30 inches is strongly calcareous, grayish-brown very fine sandy loam that is very friable. Thin strata of fine sand occur at a depth of 30 to 36 inches. Below this to a depth of 60 inches is grayish-brown very fine sandy loam.

The water table normally is at a depth of about 5 feet in these soils. Available water capacity is high. Fertility is moderate, and permeability is slow.

Because of the lack of natural surface drainage and the slow intake rate, water ponds on the surface of these soils. If these soils are drained, they are suited to all crops commonly grown in the county. Corn, sorghums, and soybeans are the main crops.

Representative profile of Onawa silty clay in a cultivated field (600 feet north and 300 feet west of the southeast corner of sec. 12, T. 26 N., R. 10 E.):

Ap—0 to 6 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; cloddy but breaks to weak, fine, granular structure; very hard when dry, firm when moist, slightly plastic when wet; calcareous; mildly alkaline; abrupt, smooth boundary.

C1—6 to 18 inches, olive-gray (5Y 5/2) silty clay, dark olive gray (5Y 3/2) when moist; strong, fine, angular blocky structure; very hard when dry, firm when moist, plastic when wet; calcareous; mildly alkaline; clear, smooth boundary.

IIC2—18 to 30 inches, grayish-brown (2.5Y 5/2) very fine sandy loam, olive brown (2.5Y 4/4) when moist; weak, medium and fine, subangular blocky structure; soft when dry, very friable when moist; a few, fine, faint, reddish-brown mottles and common, medium, distinct red mottles; strongly calcareous; moderately alkaline; gradual, smooth boundary.

IIIC3—30 to 36 inches, light brownish-gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) when moist; single grain; loose when dry and moist; strongly calcareous; moderately alkaline; gradual, smooth boundary.

IVC4—36 to 60 inches, grayish-brown (2.5Y 5/2) very fine sandy loam, olive brown (2.5Y 4/4) when moist; massive (structureless); soft when dry, very friable when moist; strongly calcareous; pH 8.8.

The A horizon ranges from dark grayish brown to grayish brown and from silt loam and silty clay loam to clay. The C1 horizon ranges from dark gray to light olive-gray silty clay or clay and extends to a depth between 18 and 24 inches. The underlying coarser textured material below the C1 horizon is predominantly loam or silt loam to very fine sandy loam and is highly stratified. Thin layers of sand occur in the lower strata in some areas.

Onawa soils are near Albaton soils and have the same color and texture in the upper part of their profile. Their C2 horizon, however, is predominantly medium textured, and that in Albaton soils is fine textured. Also, Onawa soils have more variable texture in the lower part of the profile than Albaton soils.

Onawa silty clay (0 to 1 percent slopes) (Oc).—This soil has the profile described as representative of the series. It is along the Missouri River bottom land. The areas originally were wooded, but most areas are now cleared.

This soil is suited to all crops commonly grown in the county. Wetness caused by poor drainage and the slow intake rate are the main concern of management. Where outlets are available, drainage can be provided to help correct the wetness. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Onawa and Haynie soils (0 to 1 percent slopes) (ON).—This undifferentiated unit is on bottom lands of the Missouri River. Each soil has a similar surface layer of silt loam and silty clay loam. The underlying material, however, is like that in the profile described as representative of their respective series. The Onawa soil, which makes up about 65 percent of this unit, is silty clay in the upper part of the subsoil. The Haynie soil, which makes up about 35 percent of this unit, has a very friable subsoil.

These soils are suited to all crops commonly grown in the county. Lack of drainage and the need for maintaining fertility are the main concerns of management. Capability unit IIw-4; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Ortello Series

The Ortello series consists of deep, gently sloping to sloping, well-drained soils. These soils formed under mid and tall prairie grasses in sand reworked by wind.

In a representative profile the surface layer is fine sandy loam that is dark grayish brown in the upper 12 inches and dark brown in the lower 4 inches. The subsoil is brown very friable fine sandy loam about 12 inches thick.

The underlying material is yellowish-brown fine sandy loam in the upper part and very pale brown loamy fine sand in the lower part.

The available water capacity is moderate in these soils. Fertility is medium. Permeability is moderately rapid. Runoff is medium.

These soils are easy to cultivate throughout a wide range of moisture content and are suited to most crops commonly grown in the county. They warm rapidly in spring, and crops can be planted about a week earlier than on finer textured soils. The soil is droughty. The hazards of soil blowing and water erosion are the main concerns of management.

Representative profile of Ortello fine sandy loam in a cultivated field (500 feet east and 200 feet south of the northwest corner of sec. 18, T. 26 N., R. 6 E.):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak, very fine, crumb structure that breaks to single grain; loose when dry, very friable when moist; neutral; abrupt, smooth boundary.

A1—6 to 12 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, blocky structure that breaks to single grain; slightly hard when dry, very friable when moist; neutral; clear, wavy boundary.

A3—12 to 16 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak, medium and coarse, blocky structure that breaks to single grain; slightly hard when dry, very friable when moist; neutral; gradual, wavy boundary.

B2—16 to 28 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak, coarse, prismatic structure that breaks to single grain; slightly hard when dry, very friable when moist; neutral; gradual, wavy boundary.

C1—28 to 34 inches, yellowish-brown (10YR 5/4) fine sandy loam, dark yellowish brown (10YR 4/4) when moist; weak, coarse, prismatic structure that breaks to single grain; slightly hard when dry, very friable when moist; neutral; gradual, wavy boundary.

C2—34 to 60 inches, very pale brown (10YR 7/3) loamy fine sand, pale brown (10YR 6/3) when moist; single grain; loose when dry and moist; mildly alkaline.

The A horizon ranges from dark grayish brown or dark brown in uneroded areas to grayish brown or brown in eroded areas. Its thickness ranges from 6 inches in eroded areas to 16 inches in uneroded areas. The surface texture is normally fine sandy loam, but in some eroded areas it is loamy fine sand. The B horizon ranges from brown to pale-brown fine sandy loam or sandy loam. The C horizon ranges from light fine sandy loam to fine sand, but it is predominantly loamy sand.

Ortello soils are coarser textured than Moody and Nora soils. They are finer textured than Thurman soils.

Ortello fine sandy loam, 2 to 5 percent slopes (OrB).—This soil has the profile described as representative of the series. Individual areas are small. Runoff is slow to medium, and erosion is moderate to slight. The profile varies greatly in texture and thickness within short distances because it formed in pockets within areas of overblown sand.

All of this soil is cultivated. Management is difficult because the areas range from 2 to 10 acres and are surrounded by other kinds of soil. Soil blowing is a hazard if the soil is left unprotected during long periods of dry weather. This soil is droughty. It is easy to till, and it can be cultivated throughout a wide range of moisture content. Capability unit IIIe-3; Sandy range site; Sandy windbreak suitability group.

Ortello fine sandy loam, 5 to 11 percent slopes, eroded (OrC2).—This soil is on slightly convex slopes. Runoff is medium. Much of the original surface layer has been washed away. The present surface layer is fine sandy loam to loamy sand and is 6 to 10 inches thick. Its color is dark brown because erosion has removed the original darker colored surface soil.

This soil is suited to most crops commonly grown in the county. The hazards of soil blowing and water erosion are the main concerns of management. Droughtiness is also a concern in periods when rainfall is low. Capability unit IVe-3; Sandy range site; Sandy windbreak suitability group.

Riverwash

Riverwash (Rw) consists of mixed, very fine to coarse alluvial sand that has been reworked by wind. It is on low areas adjacent to the Missouri River. In cleared areas or in areas that lack vegetation, soil blowing has formed low dunelike areas that are subject to frequent shifting. The vegetation consists of a few willows and cottonwoods that are beginning to stabilize the sand.

This land type is suitable for wildlife habitat. Areas stabilized by natural growth of trees can be used for recreation areas. Capability unit VIIIs-1; not used as range; Undesirable windbreak suitability group.

Rough Broken Land

Rough broken land (BLg) consists of very steep, rough broken areas on uplands and of narrow areas on bluffs that border the Missouri River. Small areas occur along large drainageways in the eastern one-third of the county.

Areas of Rough broken land overlie Peoria loess. Slopes generally exceed 30 percent. Outcrops of sandstone, shale, and limestone occur in many places.

The vegetation on this land type is mainly bur oak, elm, ash, and hackberry, though native grasses grow in a few areas. The grass is dominantly big bluestem and little bluestem. The trees on this land type are not of merchantable size. The areas can be used for limited grazing, but Rough broken land is better suited to use as wildlife habitat than to other uses. Capability unit VIIe-1; not used as range; Undesirable windbreak suitability group.

Sarpy Series

The Sarpy series consists of deep, nearly level, calcareous soils on bottom lands adjacent to the Missouri River. These soils formed in recent sandy alluvium laid down by overflow from the Missouri River.

In a representative profile the surface layer is light brownish-gray very fine sandy loam about 4 inches thick that is very friable and is strongly calcareous. It is underlain by 3 inches of loose, calcareous, light-gray loamy very fine sand. Below this to a depth of 60 inches is loose, calcareous, light brownish-gray sand.

Sarpy soils are excessively drained, and they are droughty. Permeability is rapid below the surface layer. Runoff is medium, and available water capacity is low. Fertility also is low.

These soils are suited to all crops commonly grown in the county. They are easy to till except that when they are dry they tend to be difficult to work because they are excessively sandy.

Representative profile of Sarpy very fine sandy loam in an area of Sarpy soils in a cultivated field (50 feet west and 840 feet north of the southeast corner of sec. 1, T. 26 N., R. 9 E.):

Ap—0 to 4 inches, light brownish-gray (10YR 6/2) very fine sandy loam, grayish brown (10YR 5/2) when moist; weak, medium and fine, angular blocky structure that breaks to weak, medium and fine, granular; loose when dry, very friable when moist; strongly calcareous; mildly alkaline; abrupt, smooth boundary.

C1—4 to 7 inches, light-gray (10YR 7/2) loamy very fine sand, grayish brown (10YR 5/2) when moist; weak, coarse, subangular blocky structure that breaks to single grain; loose when dry and when moist; calcareous; moderately alkaline; abrupt, smooth boundary.

C2–7 to 60 inches, light brownish-gray (2.5Y 6/2) sand, grayish brown (2.5Y 5/2) when moist; single grain; loose when dry and when moist; calcareous; moderately alkaline.

The A horizon ranges from dark grayish brown to light gray and from very fine sandy loam to loamy very fine sand or fine sand. The C horizon is predominantly stratified fine sand and loamy fine sand, but it includes thin strata of loamy very fine sand.

Sarpy soils are near Albaton, Haynie, and Onawa soils, but they are coarser textured and better drained than those soils.

Sarpy soils (0 to 1 percent slopes) (Sb).—This mapping unit is along the Missouri River, and in places the areas are hummocky. The surface layer ranges from very fine sandy loam to loamy very fine sand and fine sand.

These soils have low available water capacity and are droughty. They are suited to row crops, but they are very sandy and are better suited to grass, hay, and forage crops. The main concerns of management are maintaining fertility and keeping a cover of plants on the areas to prevent soil blowing. Capability unit IIIe–5; Sandy Lowland range site; Sandy windbreak suitability group.

Silty Alluvial Land

Silty alluvial land (Sy) consists of silty soil material along stream channels that in places are deeply entrenched. The areas are frequently flooded and receive fresh deposits of alluvium during each flood. The soil material is variable, but it consists mostly of dark grayish-brown highly stratified layers of calcareous silt and silty clay loam. Silty alluvial land is nearly level to gently sloping. The stream channels generally meander considerably.

Included with this land type in mapping, and making up about 15 percent of the acreage, are deeply cut creek channels and the adjoining streambanks and breaks.

Trees and brush cover 75 percent of this land type. The rest has a cover of grass, brush, and sedges. A few small patches are cultivated, but most areas are too small and are flooded too frequently for profitable cultivation. Silty alluvial land is well suited to pasture, trees, or wildlife. Some areas have been made suitable for cultivation by straightening and filling stream channels and by building terraces and dams above the areas to control silting and flooding. Capability unit VIw–1; Silty Overflow range site; Wet windbreak suitability group.

Steinauer Series

The Steinauer series consists of deep, moderately steep and steep soils on convex slopes on uplands. These soils formed under prairie grass in calcareous glacial till. They occur mostly in the southeastern part of the county.

In a representative profile the surface layer is very dark gray calcareous clay loam about 4 inches thick. Just below is 3 inches of dark grayish-brown clay loam that is firm, moderately alkaline, and strongly calcareous. At a depth below 7 inches is weathered light brownish-gray clay loam glacial till that is firm and strongly calcareous.

Steinauer soils are well drained. Runoff is rapid, and permeability is moderately slow. Available water capacity is high, and natural fertility is low. These soils are highly susceptible to erosion.

Steinauer soils generally are not cultivated, because the slopes are steep. In cultivated areas the surface layer is low in organic matter and available plant nutrients. In areas under native grass, the supply of organic matter in the surface soil is high. The natural vegetation on these soils was tall and mid prairie grasses.

Representative profile of Steinauer clay loam in an area of Steinauer soils under native grass (0.3 mile south and 100 feet east of the northwest corner of sec. 25, T. 24 N., R. 9 E.):

A1—0 to 4 inches very dark gray (10YR 3/2) clay loam, black (10YR 2/2) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; calcareous; moderately alkaline; clear, smooth boundary.

AC—4 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium and coarse, blocky structure; hard when dry, firm when moist; strongly calcareous; moderately alkaline.

C—7 to 69 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) when moist; strong, medium and fine, angular blocky structure; hard when dry, firm when moist; strongly calcareous; strongly alkaline.

The A horizon ranges from very dark gray in uneroded areas to dark grayish brown in cultivated areas. Its texture ranges from clay loam to silty loam. The AC and C horizons range from dark grayish brown to light gray in color, and from clay loam and silty clay loam to light silty clay in texture. The profile is calcareous within 10 inches of the surface in uneroded areas, and at the surface in eroded areas.

In some places pebbles are scattered on the surface and in all or some of the horizons. A few small to large boulders are on the surface or in one of the lower horizons.

Steinauer soils are near Burchard soils. They occur on steeper slopes than Burchard soils, but generally are below Crofton, Ida, and Monona soils. Steinauer soils have a thinner A horizon than Burchard soils and lack the distinct B2t horizon of those soils.

Steinauer soils, 11 to 30 percent slopes (StE).—This is the only unit of Steinauer soils mapped in the county. It is on slightly convex slopes along deeply dissected drainageways. The average slope is 18 percent.

This mapping unit includes both eroded and uneroded areas. Runoff is rapid. Pebbles, small rocks, and a few boulders are on the surface.

Included with this unit in mapping are small areas of Crofton, Ida, and Monona soils.

Many areas of these Steinauer soils are small and therefore are difficult to manage separately from surrounding soils. These soils are well suited to grass, and where possible or feasible should be kept in native grass. In areas cultivated or overgrazed, gullies form readily in natural drainageways. Capability unit VIe–9; Limy Upland range site; Silty to Clayey windbreak suitability group.

Thurman Series

The Thurman series consists of well-drained, gently sloping to moderately sloping soils on uplands. These soils formed under mid and tall prairie grasses in noncalcareous, sandy deposits in the mixed sand and loess area of the county.

In a representative profile the surface layer is dark-brown loamy fine sand about 10 inches thick. The next layer is 10 inches of brown loamy sand. At a depth between 20 and 60 inches is light yellowish-brown sand.

Permeability is rapid in these soils, and fertility is low. These soils have low available water capacity and are droughty. Soil blowing is a severe hazard. If these soils are cultivated, they are well suited to corn, sorghum, rye, and sudangrass.

Representative profile of Thurman loamy fine sand in a cultivated field (1,800 feet east and 105 feet north of the southwest corner of sec. 1, T. 26 N., R. 5 E.):

Ap—0 to 10 inches, dark-brown (10YR 3/3) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grain; loose when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

AC—10 to 20 inches, brown (10YR 5/3) loamy sand, dark grayish brown (10YR 4/2) when moist; weak, coarse, blocky structure that breaks to single grain; loose when dry, very friable when moist; slightly acid; clear, wavy boundary.

C—20 to 60 inches, light yellowish-brown (10YR 6/4) sand when dry and moist; single grain; loose when dry and moist; neutral.

The A horizon ranges from very dark grayish brown to dark brown in color and from loamy sand to sand in texture. It ranges from 6 to 12 inches in thickness. The AC horizon ranges from loamy sand to loamy fine sand and from brown to yellowish brown. The C horizon ranges from sand to loamy sand.

Thurman soils are near Moody and Ortello soils but lack the B horizon of those soils.

Thurman loamy sand, 1 to 7 percent slopes (TcB).—This soil has the profile described for the series. It is on convex ridgetops in areas that range from 3 to 20 acres. Runoff is slow. Soil blowing is a serious hazard.

Included with this soil in mapping are small areas of Moody fine sandy loam and of Ortello soils.

This Thurman soil is better suited to corn, sorghums, sudangrass, and rye than to other crops. Available water capacity is low, and this soil is droughty. Other concerns of management are protecting the soils from blowing and maintaining fertility. Capability unit IIIe-5; Sandy range site; Sandy windbreak suitability group.

Thurman soils, 7 to 17 percent slopes (TxE).—These soils are mainly on ridgetops and side slopes. Except that uneroded areas have a very dark grayish-brown surface layer, the profile is similar to that described as representative of the series. Runoff is medium.

Included with this soil in mapping are small areas of soil where the underlying material is coarser textured than that of this soil. These areas are associated with deposits of glacial till and occupy an area drained by North and South Blackbird Creeks. Some of the areas are a local source of sand and gravel.

These soils are not suitable for cultivation because of the slope and the hazard of soil blowing. They are well suited to native grasses or to trees. Capability unit VIe-5; Sands range site; Sandy windbreak suitability group.

Wet Alluvial Land

Wet alluvial land (Wx) consists of nearly level, very poorly drained soil material along upland streams and in old river channels of the Missouri River. These level and depressional areas are from 3 to 10 acres in size. Slopes range from 0 to 1 percent.

The surface layer ranges from silt loam to silty clay. The subsoil ranges from loam and silt loam to clay and commonly is mottled. The water table is at a depth of 1 to 3 feet, but in places it is at the surface for part of the year.

Included with this land type in mapping are small areas of Lamo soils.

Wet alluvial land is too wet for cultivation. The natural vegetation is prairie cordgrass and other grasses and plants that tolerate wetness. The areas are used mainly for hay and pasture. Lack of drainage and the high water table are the main concerns of management. Capability unit Vw-1; Wet Land range site; Wet windbreak suitability group.

Zook Series

The Zook series consists of deep, poorly drained, nearly level soils on bottom lands. These soils are along the principal drainageways. They formed in noncalcareous fine-textured alluvium.

In a representative profile the surface layer is very dark brown silty clay to a depth of 4 inches; firm, black silty clay to a depth of 14 inches; and firm, very dark gray silty clay to a depth of 32 inches. The subsoil, between a depth of 32 to 41 inches, is very dark gray clay that is extremely firm. The substratum is very firm, dark-gray silty clay.

Permeability is slow in Zook soils. Available water capacity is moderate, and fertility is high.

If Zook soils are drained, they are suited to all crops commonly grown in the county. The native vegetation was tall prairie grass.

Representative profile of Zook silty clay (800 feet south and 100 feet west of the northeast corner of sec. 8, T. 25 N., R. 6 E.):

Ap—0 to 4 inches, very dark brown (10YR 2/2) light silty clay, black (10YR 2/1) when moist; weak, fine and very fine, granular structure; slightly hard when dry, friable when moist; slightly acid; abrupt, smooth boundary.

A11—4 to 8 inches, black (10YR 2/1 dry and moist) light silty clay; weak, medium, angular blocky structure that breaks to weak, coarse, granular; hard when dry, firm when moist; slightly acid; abrupt, smooth boundary.

A12—8 to 14 inches, black (10YR 2/1 dry and moist) light silty clay; weak, coarse, subangular blocky structure that breaks to moderate, very fine, angular blocky; very hard when dry, firm when moist; neutral; abrupt, smooth boundary.

A13—14 to 32 inches, very dark gray (10YR 3/1 dry and moist) silty clay; moderate, coarse, prismatic structure that breaks to moderate, coarse, subangular blocky; extremely hard when dry, extremely firm when moist; a few fine, distinct, black mottles; slightly acid; gradual, smooth boundary.

Bg—32 to 41 inches, very dark gray (10YR 3/1 dry and moist) clay; weak, medium, prismatic structure that breaks to moderate, coarse, angular blocky; extremely hard when dry, extremely firm when moist; a few, fine, distinct, black mottles; slickensides are common; neutral; clear, smooth boundary.

Cg—41 to 60 inches, dark-gray (10YR 4/1 dry and moist) silty clay; weak, fine, prismatic structure that breaks to moderate, medium, subangular blocky and angular; hard when dry, very firm when moist; a few, fine, distinct, black mottles; neutral.

The A horizon ranges from silty clay loam to light silty clay in texture, and from black and very dark brown to very dark gray in color. It ranges from about 26 to 40 inches in thickness. A few dark-colored, hard concretions occur in the B and C horizons in places.

Zook soils are near Colo, Lamo, and Luton soils. They are finer textured than Colo and Lamo soils. Unlike the calcareous Lamo and Luton soils, Zook soils are noncalcareous.

Zook silty clay loam (0 to 1 percent slopes) (Zo).—This soil has a silty clay loam surface layer 7 to 14 inches thick, but its profile otherwise is like that described as representative of the series. Runoff is slow.

Included with this soil in mapping are small areas of Colo silty clay loam.

This Zook soil is suited to all crops commonly grown in the county. The main concerns of management are poor drainage and maintaining fertility. Capability unit IIIw-2; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Zook silty clay (0 to 1 percent slopes) (Zc).—This soil has the profile described as representative of the series. Runoff is very slow to ponded. Some areas of this soil formerly were wet marshes, but the wetness has been corrected by drainage.

If adequate drainage is provided, this soil is suited to all crops commonly grown in the county. Because of its fine texture, this soil dries out slowly in spring. As a result tillage and planting are delayed in some years. Fall plowing helps the soils to dry out and warm up in spring so that planting and other fieldwork can be done earlier. Capability unit IIIw-1; Clayey Overflow range site; Moderately Wet windbreak suitability group.

Management of the Soils for Crops[2]

In this section the capability system used to classify soils for the production of cultivated crops and pastures is explained and management of the soils in the county by capability units is discussed. Then a table showing predicted yields of the principal crops is given.

The soils of Thurston County are fertile, and under good management they are well suited to crops. The chief concerns of management are water erosion on upland soils, flooding adjacent to streams, and maintaining fertility. About 28 percent of the soils in the county have slopes of more than 10 percent. Many areas of the strongly sloping Crofton, Ida, Monona, and Nora soils formerly were cultivated but are now in grass. Because of excessive runoff, water erosion is a serious hazard on these upland soils, and in many areas both sheet and gully erosion are evident. Much of the original surface layer of the soils has been washed away and the soil material has been deposited in the valleys. Thus, fertility of the soils in the uplands has been reduced.

Corn is the major row crop in Thurston County, though soybeans and grain sorghum are also important. Where flooding is not a serious hazard, row crops are grown extensively on soils on bottoms, such as the Haynie, Kennebec, Judson, Luton, and McPaul. Row crops also are grown on large acreages of such upland soils as Crofton, Ida, Moody, Monona, and Nora.

Oats, alfalfa, and pasture grasses are also major crops, but wheat, barley, and rye are grown in smaller acreages. Some areas formerly used for crops are now idle. Most of the idle areas are part of the diverted acreage in the Government crop-control programs.

The pastures in the county consist mainly of bromegrass or of a mixture of bromegrass and alfalfa. Most pastureland is part of a long-time cropping system. Such use is especially suited on severely eroded soils and on soils that are frequently flooded.

Irrigated cropland in Thurston County accounts for only a small acreage. According to the 1968 Nebraska Agricultural Statistics report, 2,300 acres in the county are irrigated. The irrigation water is used chiefly to supplement natural rainfall during dry years. Soils that are level to very gently sloping are most suitable for irrigation. On slopes of more than 8 percent, irrigation causes water erosion and loss of irrigation water through excessive runoff.

If suitable quantities of underground water are available, the acreage of irrigated land can be increased. Also the acreage in pasture and rangeland, as well as further improvement of management practices, particularly on gently sloping soils, also could be increased.

Suitable practices for control of erosion are terracing, farming on the contour, and using grassed waterways. In addition a cropping system that includes mulch tillage and limited use of row crops is needed on the gently sloping and moderately sloping Monona, Moody, and Nora soils. Soils on bottoms, such as the Haynie, Kennebec, Judson, Luton, and McPaul, require protection from flooding. Flooding can be reduced by using diversion terraces on upland areas above the flooded areas and the use of other practices that help to conserve soil and water.

Producing enough crop residue to maintain erosion control is not always possible on the steeper Crofton, Ida, Monona, and Nora soils. A cover of grass or hay crops therefore is needed on those soils and on sloping soils in pasture to help to provide protection from erosion.

Leaving all crop residue on the surface during tillage helps to reduce losses of soil through water erosion and soil blowing. Stubble mulching and tillage planting methods of preparing the seedbed are ways or reducing sedimentation.

Fertilizer should be applied according to the results of soil tests. The amount of moisture in the soil also should be considered. For example, less fertilizer is needed on soils that have a dry subsoil during a period of low rainfall than in a year when the supply of moisture is adequate. Crops on nearly all of the soils respond if nitrogen fertilizer is applied. Phosphorus and zinc generally are needed on eroded soils on uplands, such as those of the Crofton, Ida, Monona, Moody, and Nora series.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and

[2] By E. O. PETERSON, conservation agronomist, Soil Conservation Service.

the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or to other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system, all kinds of soil are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.
- Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, II-1 or III-5. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the pages that follow, the capability units in Thurston County are described and suggestions for the use and management of the soils are given. Capability units generally are identified by numbers assigned locally and are part of a statewide system. Not all the units in the system are represented in Thurs[illegible] County, and the capability units described in this s[illegible]y therefore are not numbered consecutively. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all soils of a given series appear in the unit. The names of all soils in any given capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Capability unit I-1

This unit consists of deep, nearly level, moderately well drained and well drained soils of the Belfore, Haynie, Judson, Kennebec, and Moody series. These soils are on bottom lands, stream terraces, and uplands. They have a surface layer of silt loam or silty clay loam.

The available water capacity is high in these soils, and moisture is readily released to crops. Permeability of the subsoil is moderate to moderately slow. The content of organic matter is moderate to high. These soils are easily penetrated by roots, air, and water. They are suitable for intensive farming and are easy to till. Minor infrequent flooding occurs on the bottom lands.

These soils are suited to all crops commonly grown in the county, and they are especially suited to corn, soybeans, and grain sorghum. Row crops can be grown year after year if proper amounts of fertilizers are added and if weeds and insects are controlled. These soils are also suitable for pasture.

Grassed waterways are needed to conduct runoff across these soils. In places diversion ditches help to prevent damage by runoff from higher areas. Grassing the turnrows and field roads helps to control weeds along field borders.

Capability unit IIe-1

This unit consists of deep, gently sloping soils of the Judson, Monona, and Moody series. These soils are on uplands and stream benches where erosion is slight to moderate. They have a surface layer and subsoil of silt loam or silty clay loam. Slopes range from 1 to 7 percent.

The available water capacity is high in these soils, and moisture is released readily to plants. Permeability is moderate to moderately slow. The content of organic matter is moderate to high. Fertility is high, and the soils are easily and deeply penetrated by roots. In cul-

tivated areas water erosion is the chief hazard, and maintaining fertility is difficult.

These soils are suited to all crops commonly grown in the county. On long slopes terracing, contour farming, and grassed waterways are needed to keep water from concentrating. A cropping system that includes grasses and legumes helps to control erosion and to build up the supply of organic matter, maintain fertility, and improve tilth.

Many farmsteads are located on areas of these soils. The soils are well suited to plantings for windbreaks and for garden crops.

Capability unit IIw-3

In this unit are deep, nearly level soils of the Lamo and McPaul series. These soils are on bottom lands. They have a surface layer of silt loam and a subsoil that has moderate to moderately slow permeability. The soils absorb and hold water and release it readily to plants. They are easy to till, and roots penetrate them easily.

These soils are subject to occasional flooding for short periods, especially after heavy rains in spring. Planting therefore is likely to be delayed because of wetness, or crops and pasture plants are damaged by silty deposits left by the floodwater. Damage to crops seldom is severe. Silt from the floods damages fences, however, and eventually fills drainage ditches and ditches along roads. In dry years the runoff benefits crops somewhat. Terracing the adjacent uplands and using diversions are ways to protect these soils from flooding.

Soils in this unit are suited to all crops commonly grown in the county. Alfalfa is damaged by silt unless the adjacent uplands are protected by measures that control erosion. If these soils are managed properly, row crops can be grown year after year and productivity maintained.

Capability unit IIw-4

This unit consists of deep, poorly drained to moderately well drained soils of the Colo, Haynie, Lamo, and Onawa series. These soils are on bottom lands. They have a surface layer of silt loam or silty clay loam and a subsoil that has moderate to slow permeability. The water level fluctuates at a depth between 2 and 8 feet. During seasons of excessive moisture, the high water table makes the soils wet and difficult to till. In dry years crops obtain some moisture from the water table because of subirrigation. The soils generally absorb water well and release it readily to plants.

These soils are suited to all crops commonly grown in the county, but corn, soybeans, and grain sorghum are the principal crops. Small grains seeded in spring are seldom grown. Yields of alfalfa vary because in some years the root zone is restricted by a high water table that damages the plants. Many areas remain in grass and are used for pasture (fig. 12).

Occasional flooding and runoff from higher areas are the chief concerns on these soils. Shallow drains are used to remove impounded surface water. Drainage ditches and tile help to control the water table and wetness.

Capability unit IIIe-1

This unit consists of deep, moderately sloping soils of the Burchard, Monona, Moody, and Nora series. These soils are on uplands. They have a surface layer of silt loam to silty clay loam and a subsoil that has moderate to moderately slow permeability. Slopes range from 5 to 11 percent.

***Figure 12.*—Pasture on Colo silty clay loam.**

Runoff is moderate on these soils. The available water capacity is high. Fertility and content of organic matter are medium to high. Erosion is slight to moderate, and part of the original surface layer has been washed away in areas cultivated without proper conservation practices. Maintaining soil structure and fertility, controlling runoff, and conserving moisture are the chief concerns of management if these soils are cultivated.

These soils are easily and deeply penetrated by roots and are easy to work. They are suited to all crops commonly grown in the county. The hazard of erosion is more severe if soybeans are grown than if other tilled crops are grown. Erosion can be controlled by the use of terraces, contour farming, grassed waterways, and minimum tillage (fig. 13).

Capability unit IIIe-3

This unit consists of deep, gently sloping to sloping soils of the Moody and Ortello series. These soils are on uplands. They have a surface layer of fine sandy loam. The subsoil of Ortello soils is sandy loam, and that of Moody soils is silty clay loam.

Soil blowing and water erosion have eroded most of these soils somewhat. The soils absorb water readily and release it readily to plants. The available water capacity is moderate in the Ortello soils and high in the Moody soils. Ortello soils are droughty.

These soils are easy to cultivate and are suited to all crops commonly grown in the county. They are highly erodible if soybeans are grown. Control of soil blowing and water erosion is needed. Terracing, contour farming, stripcropping, and use of grassed waterways are ways of controlling erosion. In addition tillage should be kept to a minimum and shelterbelts planted along fields. Growing legumes or mixtures of grasses and legumes in the cropping system helps to replenish the content of organic matter

Figure 13.—**Waterways, terraces, and contour farming on Moody silty clay loam, 7 to 11 percent slopes.**

and to maintain fertility and control soil blowing. Keeping a cover of crops on the areas and using a cropping system in which close-growing crops follow a row crop help to build up the soil and to control erosion.

Capability unit IIIe-5

This unit consists of gently sloping to nearly level sandy soils of the Sarpy and Thurman series. These soils are on uplands and bottom lands along the Missouri River. They have a surface layer of very fine sandy loam to loamy sand and a subsoil of sand to loamy sand.

These soils absorb water well and release it readily to plants. Available water capacity is low, and permeability is rapid. Erosion generally is slight to moderate. These soils are easy to till. They need to be protected from soil blowing when dry. Conserving moisture, maintaining fertility, and preventing erosion are needed for good crop growth.

The soils in this unit are suited to all crops commonly grown in the county. Rye and vetch can be used as cover crops or as green manure. Stripcropping, minimum tillage, and planting shelterbelts along fields help to control soil blowing and to conserve moisture.

Thurman soils are slightly acid and require lime, but Sarpy soils are alkaline and need no lime. Both soils are low in fertility. Crops on them respond well if fertilizer is applied and if adequate moisture is available.

Capability unit IIIe-8

This unit consists of deep soils of the Crofton, Monona, Moody, and Nora series. These soils have a surface layer of silt loam to silty clay loam and a subsoil that has moderate to moderately slow permeability. They are severely eroded, have a low content of organic matter, and are highly susceptible to sheet, rill, and gully erosion. Water is absorbed readily, and it is released readily to plants.

These soils are suited to most crops commonly grown in the county, but they are highly erodible if used for soybeans. Because of erosion, the content of organic matter generally is low. Growing such soil-building crops as grasses and legumes and returning all residues to the soils are ways of restoring the structure and content of organic matter. Use of contour farming, terraces, waterways, and field borders are ways to help prevent erosion, conserve moisture, restore fertility, and control runoff. On some slopes stripcropping helps to reduce erosion. Loss of fertility is serious on these eroded soils, and fertilizer is needed for good crop growth.

Capability unit IIIw-1

In this unit are deep, nearly level, poorly drained soils of the Albaton, Luton, Onawa, and Zook series. These soils are on bottom lands. They have a surface layer of silty clay and a subsoil that is slowly permeable. These soils have slow surface drainage or a water table at a depth between 2 and 10 feet, or both. They absorb water slowly and release it slowly to plants. During wet periods cultivation is difficult or is delayed, but during dry periods crops receive some moisture from the underlying water table.

Wheat, corn, and soybeans are the principal crops on these soils. Because of slow internal drainage, water ponds occasionally on the surface and delays planting or drowns out the crops. Adding organic material and avoiding working the soils when wet help to prevent puddling and to improve tilth. The high content of clay makes tillage difficult. If these soils are plowed when wet, large clods form. Alkali spots are common in Luton silty clay.

Plowing in fall helps to improve structure of these soils and to provide a better seedbed because freezing and thawing in winter break up the large clods. If the soils are left bare, however, they are susceptible to soil blowing.

Using field windbreaks, wind stripcropping, or cover crops helps to prevent soil blowing. Excessive compaction by machinery or livestock reduces the permeability of the soils to air and water. Growing mixtures of grasses and legumes in the cropping system helps to maintain fertility and tilth.

The soils in this unit generally are too impermeable for tile drains to effectively correct the wetness. Shallow surface drains can be used to remove excess surface water (fig. 14). Row arrangement, surface bedding, field drains, and control of weeds in drainage ditches are practices that help to improve surface drainage.

Capability unit IIIw-2

This unit consists of deep, nearly level, poorly drained soils of the Albaton, Luton, and Zook series. These soils are on bottom lands. They have a surface layer of silty clay loam and a subsoil of slowly permeable silty clay. The surface layer is easy to work and absorbs water readily, but the subsoil absorbs water slowly and releases it slowly to plants.

These soils are suited to all crops commonly grown in the county. Because of the slow permeability of the subsoil, water occasionally ponds on the surface and delays tillage or harvesting of crops. Keeping tillage to a minimum and working the soil only under the proper moisture content are ways of avoiding soil compaction by machinery. If the soils are compacted, aeration and movement of water in the soil are reduced and the soils are more difficult to till and to manage.

These wet soils generally are slowly permeable, and tile laid in them does not work well enough to correct the wetness. Shallow surface drains can be used to reduce surface ponding. Diversions, field drains, row arrangement, and open drainage ditches all help to improve surface drainage.

Capability unit IVe-1

This unit consists of deep, well-drained soils of the Burchard, Monona, and Nora series. These soils have a surface layer of silt loam and a subsoil that has moderate to moderately slow permeability. Slopes are 11 to 17 percent.

These soils are friable and are easy to work. They absorb and store water well and release it readily to plants. Roots penetrate easily and deeply. Runoff is rapid. Erosion is slight to moderate, and sheet, rill, and gully erosion are serious hazards.

These soils are suited to most crops commonly grown in the county, but soybeans are poorly suited. Because the hazard of erosion is high on these soils, row crops or clean-tilled crops should not follow each other in the cropping sequence. Growing legumes and grasses about 80 percent of the time in the cropping sequence and returning crop residue and barnyard manure to the soils are ways of controlling erosion, maintaining fertility, and improving tilth. Use of contour farming, terraces, grassed waterways, stripcropping, and grass turnrows also help to control erosion.

Use of tillage that leaves crop residues at or near the surface helps to reduce runoff and also increases the rate of water intake. The slopes and erosion hazard make permanent grass or hay crops grown for forage the most suitable uses for these soils.

***Figure 14.*—Shallow open drainage ditch provides surface drainage on soils in capability unit IIIw-1.**

Capability unit IVe-3

Ortello fine sandy loam, 5 to 11 percent slopes, eroded, is the only soil in this unit. Its surface layer and subsoil are fine sandy loam. This soil absorbs water readily. The available water capacity is moderate, and in long dry periods the soil is somewhat droughty.

This soil is suited to most crops commonly grown in the county. The hazard of erosion, however, makes the soil better suited to pasture or forage crops than to cultivated crops. Soil blowing and water erosion are the chief hazards, though loss of fertility and droughtiness are concerns. Where feasible, terracing, waterways, and contour farming can be used to protect these soils. In addition stripcropping and minimum tillage are effective measures. Because the subsoil and underlying material are sandy, grassed waterways are difficult to maintain. In places lime is needed for starting legumes.

Capability unit IVe-8

In this unit are deep, eroded soils of the Burchard, Crofton, Ida, Monona, and Nora series. Slopes are 7 to 17 percent. All of the original dark-colored surface layer has been washed away. The present surface layer is low in content of organic matter and is low to medium in fertility. It is silt loam in all except the Burchard soil, which has a surface layer of clay loam. The subsoil is moderately permeable in all except the Burchard soil, which has a subsoil that is moderately slowly permeable.

The soils in this unit are subject to severe sheet, rill, and gully erosion. Under good management, they absorb water readily and release it readily to plants. Roots penetrate the soils easily and deeply.

Except for soybeans, these soils are fairly well suited to most crops grown in the county. Seeding grass and mixtures of grass and legumes help to restore the content of organic matter and to improve fertility. Suitable practices for conserving soil and moisture and for controlling runoff are farming on the contour and terracing. In addition grassed waterways, turnrows, and field borders are needed. Keeping a cover of permanent vegetation on these soils, such as grass or trees, is the most effective method of conserving soil and water.

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Capability unit IVe–9

Ida silt loam, 11 to 17 percent slopes, is the only soil in this unit. It has a thin surface layer but is only slightly eroded because the areas are mainly under grass or trees. The surface layer and underlying material are silt loam. If this soil is cultivated it is subject to severe water erosion unless intensive practices for conserving soil and water are used.

Except for soybeans, all locally suited crops can be grown on this soil. Difficulty of maintaining fertility and the severe hazard of erosion, however, make the soil better suited to grass, to mixtures of grasses and legumes, or to forage crops than to other crops.

Most areas of this soil are in grass or trees and are expected to remain in grass or trees.

Capability unit Vw–1

Only Wet alluvial land is in this unit. This land type consists of level, deep, silty to clayey soil material on very wet bottom lands. The water table is at or near the surface most of the year and makes the areas unsuitable for cultivation.

Areas of Wet alluvial land in upland drainageways are in native pasture or hay. In some places willows, cattails, prairie cordgrass, sedges, and other plants that tolerate wetness grow on these areas. On the bottom land along the Missouri River, areas of Wet alluvial land are covered mostly with weeds. Some of these areas are being drained for farming.

Wet alluvial land is so wet in some seasons that grazing is limited. Surface drains and tile drains help to lower the water table and to provide drainage so that the more desirable grasses can be established.

Capability unit VIe–1

Monona silt loam, 17 to 31 percent slopes, is the only soil in this unit. The subsoil is moderately permeable. This steep soil is highly susceptible to water erosion and is slightly to moderately eroded. It is not suitable for cultivation.

This soil is well suited to grass and trees. If the soil is used for grazing, mowing or spraying helps to control weeds and undesirable plants. Small isolated areas of this soil surrounded by cropland or adjacent to cropland can be used for hay or grazing along with the crop aftermath. Trees and shrubs can be planted and managed for wildlife. Good sites for watering areas for livestock or for recreational dams occur along drainageways in this soil.

Capability unit VIe–5

Only Thurman soils, 7 to 17 percent slopes, are in this unit. These soils have a surface layer of loamy fine sand underlain by loamy sand and sand. Available water capacity is low in these soils, and fertility generally is low.

These soils are not suited to cultivation. They are very sandy, and if they are cultivated, they are susceptible to soil blowing and water erosion. They are better suited to grass or trees and to wildlife habitat areas than to cultivated crops.

Capability unit VIe–8

This unit consists of deep soils in the Crofton, Ida, and Nora series. The surface layer is silt loam, and the subsoil is moderately permeable. Slopes range from 17 to 31 percent, and the soils are severely eroded.

The soils in this unit absorb water readily and release it readily to plants. Roots penetrate easily and deeply. Rapid runoff on the steep slopes makes sheet and rill erosion severe unless an adequate cover of plants is kept on the areas. Also gullies are likely to form.

These soils are better suited to grass and trees than to cultivated crops. Areas now cultivated should be converted to grass or trees. Under good management an adequate cover of plants can be maintained and losses of soil, water, and plant nutrients reduced. Small isolated areas can be seeded to grass or planted to trees and shrubs for use by wildlife. Mixtures of native grasses similar to the climax vegetation on these soils are well suited. Good sites for watering areas for livestock or for recreational dams occur along some areas of these soils.

Capability unit VIe–9

This unit consists of deep soils of the Ida and Steinauer series. These soils have a thin surface layer of silt loam to clay loam. Their subsoil is moderately permeable to moderately slowly permeable. Roots penetrate easily and deeply. Slopes range from 17 to 31 percent.

These soils erode rapidly if cultivated. They are better suited to native grasses and trees than to cultivated crops. Under good management an adequate cover of plants can be maintained and losses of soil and water reduced. In places good sites are available in these soils for farm ponds and wildlife areas.

Capability unit VIw–1

Only Silty alluvial land is in this unit. It consists of silty material on bottom lands that are inaccessible or are frequently flooded. In places the areas are cut by crooked stream channels. It is not practical to cultivate this land type, and most areas have a cover of trees, brush, and weeds.

This land type is suitable for grass or trees. Flooded areas that lack a cover are suitable for reseeding to grass or planting to trees for grazing or for use as woodland. Wooded and brushy areas that are not used for grazing provide an excellent habitat for wildlife.

Capability unit VIIe–1

Only Rough broken land is in this unit. It consists of very steep bluffs along the Missouri River Valley. This land type supports a cover mainly of trees and brush, though some small areas have a cover of grass. The plant cover helps to control runoff and to reduce erosion.

Rough broken land is used for limited grazing. It is suited to use for recreation areas and provides both food and cover to upland game.

Capability unit VIIIe–1

Only Gullied land is in this unit. It is not suitable for crops or grasses.

Gullied land consists of areas cut by gullies in channels of upland drainageways. In these areas the stream grade has been increased by channel straightening or lowering of the base grade. The banks of the gullies are 10 to 30 feet deep and have active overfalls at the heads.

Diverting water from the gullies and establishing a cover of grass and trees where feasible help to stabilize them and keep them from enlarging. Dams and drop

inlet structures are effective in reducing the grade of the watercourses and stopping the advance of the overfalls. In many areas trees and shrubs growing along the gullies help to stabilize the gully walls.

Gullied land is well suited to use as wildlife habitat. The areas provide cover for upland game.

Capability unit VIIIw-1

Only Marsh is in this unit. It consists of wet sandbars and mudflats. These areas were formerly a part of the river channel, and stabilization work has diverted the channel from them. Willows and aquatic plants are first to invade the wet areas. On the more stabilized areas are scattered dense stands of willows, cottonwoods, brush, annual weeds, common reedgrass, cattails, and rushes. Marsh provides excellent habitat for waterfowl and is used primarily for recreation (fig. 15).

Capability unit VIIIs-1

Only Riverwash is in this unit. It consists of mixed alluvial sand along the banks of the Missouri River.

Riverwash is not suited to crops or grass, but trees grow in scattered areas. Soil blowing is severe, and in places the sand is piled into dunes that are 10 feet high. In a few places willows and cottonwoods are beginning to stabilize the sand. Riverwash is better suited to recreation and wildlife areas than to other uses.

Predicted Yields

The predicted average acre yields of the principal crops grown on the soils of Thurston County are given in table 2. These predictions are based on information obtained from farmers in the county and on observations made by agricultural workers and others who are familiar with the soils. In periods when rainfall is above average, the yields are higher than those listed. New techniques of management and new varieties of crops could cause changes in yields.

The predicted yields in table 2 are listed under two levels of management. In columns A are yields that can be expected under average management, or the kind of management most farmers were using at the time the soil survey was made. Under this management a cropping sequence is used that provides some control of erosion; insects and diseases are controlled; fertility is maintained; and seedbed preparation, planting, and tilling practices provide for adequate stands of adapted crop varieties and for weed control.

The yields in columns B are obtained under improved management. This high level of management includes use of practices for controlling soil blowing and water erosion; use of cropping sequences that provide for maintaining tilth and content of organic matter; applying fertilizer as indicated by soil tests; planting adapted crop varieties at the proper rate; controlling insects, weeds, and diseases; and performing all practices at the proper time.

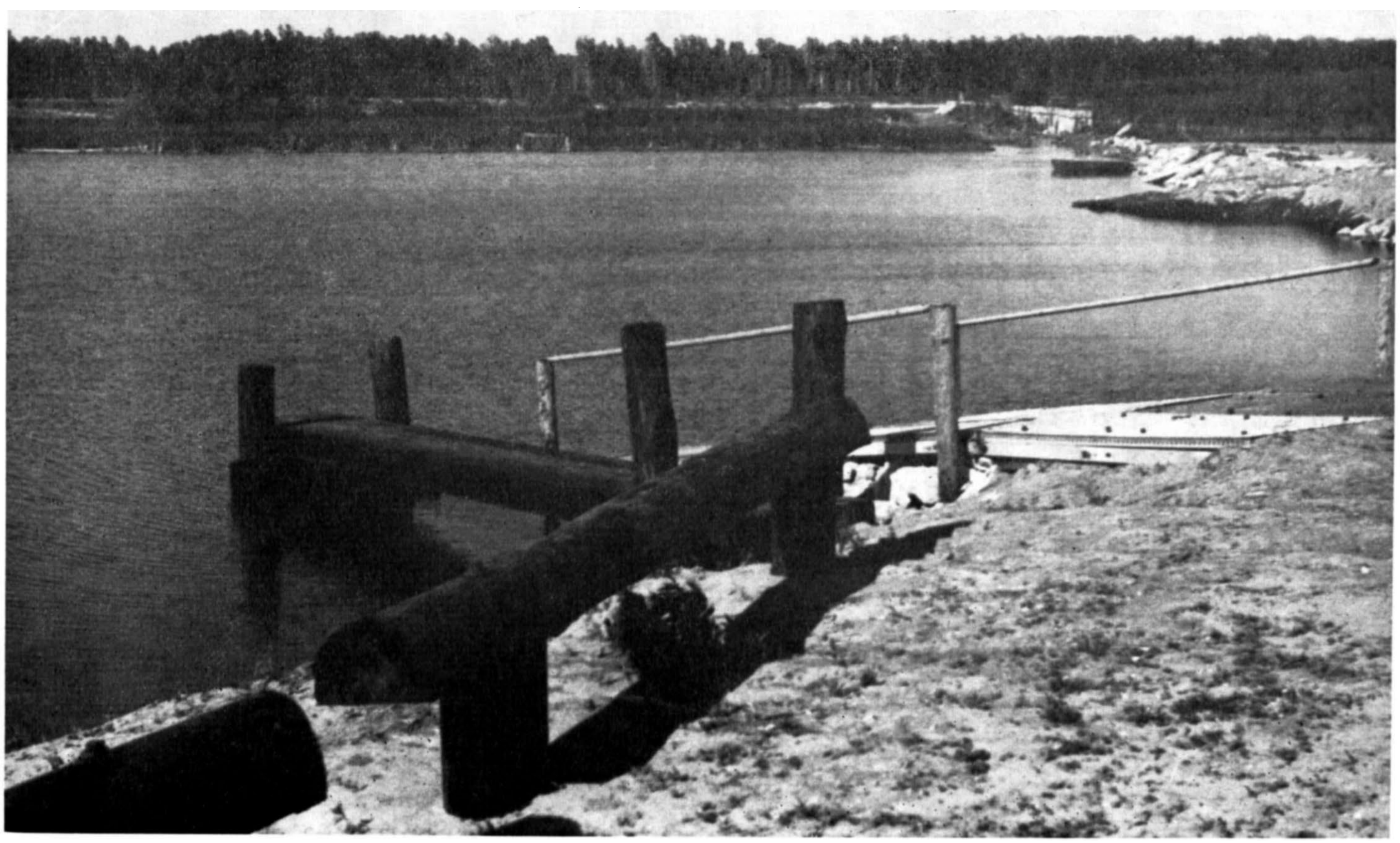

Figure 15.—Marsh and lakes provide excellent recreational areas. (*Courtesy of Bureau of Indian Affairs.*)

TABLE 2.—*Predicted average acre yields of principal crops*

[In columns A are yields under ordinary management; in columns B are yields under improved management. Absence of yield indicates the crop is not suited to the soil or that it is grown only in small amounts]

Mapping unit	Corn		Oats		Alfalfa hay		Soybeans		Grain sorghum		Brome and alfalfa pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Animal-unit-month* [1]	*Animal-unit-month* [1]
Albaton silty clay loam	65	90	20	42	3.0	5.0	26	36	60	100	2.0	3.6
Albaton silty clay	55	75	25	40	3.0	5.0	22	35	55	80	2.6	4.5
Belfore-Moody silty clay loams, 0 to 1 percent slopes	70	115	45	60	3.5	4.5	32	40	85	110	2.0	4.8
Burchard silt loam, 5 to 11 percent slopes	40	65	25	35	1.5	3.0	------	------	50	85	1.2	2.5
Burchard silt loam, 11 to 17 percent slopes	35	60	20	30	1.5	2.5	------	------	45	75	1.0	2.0
Burchard clay loam, 11 to 17 percent slopes, eroded	30	55	20	30	1.0	2.0	------	------	40	70	.8	1.5
Colo silty clay loam	78	110	20	40	3.0	4.0	31	40	85	100	4.0	5.0
Crofton silt loam, 1 to 7 percent slopes, eroded	40	80	25	40	1.5	4.0	------	------	30	80	.8	1.5
Crofton silt loam, 7 to 11 percent slopes, eroded	35	70	20	40	1.5	4.0	------	------	30	80	.7	1.2
Crofton silt loam, 11 to 17 percent slopes, eroded	32	65	20	35	1.5	3.5	------	------	30	75	.7	1.2
Crofton silt loam, 17 to 31 percent slopes, eroded [2]	------	------	------	------	------	------	------	------	------	------	------	------
Gullied land [3]	------	------	------	------	------	------	------	------	------	------	------	------
Haynie silt loam	60	85	25	35	3.0	5.0	20	25	60	90	2.0	4.8
Ida silt loam, 7 to 11 percent slopes, eroded	37	72	22	42	1.5	4.0	------	------	32	82	.7	1.2
Ida silt loam, 11 to 17 percent slopes [4]	------	------	------	------	------	------	------	------	------	------	------	------
Ida silt loam, 11 to 17 percent slopes, eroded	32	65	20	35	1.5	3.5	------	------	30	75	.7	1.2
Ida silt loam, 17 to 31 percent slopes [2]	------	------	------	------	------	------	------	------	------	------	------	------
Ida silt loam, 17 to 31 percent slopes, eroded [2]	------	------	------	------	------	------	------	------	------	------	------	------
Judson silt loam, 0 to 2 percent slopes	70	115	34	40	4.0	4.5	32	42	75	100	3.0	5.0
Judson silt loam, 2 to 7 percent slopes	68	110	30	40	4.0	4.5	30	40	75	110	3.0	5.0
Kennebec silt loam	80	120	40	60	3.0	4.0	32	42	85	120	4.0	5.0
Lamo silt loam, overwash	70	100	30	50	3.0	4.5	28	40	70	110	3.3	5.0
Lamo silty clay loam	60	90	------	------	3.0	4.5	28	38	70	100	2.5	5.0
Luton silty clay loam	60	90	25	42	3.0	5.0	25	42	65	90	2.5	5.0
Luton silty clay	55	80	20	40	3.0	5.0	20	37	60	80	2.5	5.0
Marsh [3]	------	------	------	------	------	------	------	------	------	------	------	------
McPaul silt loam	65	98	38	44	3.0	4.0	25	32	60	110	3.3	5.0
Monona silt loam, 1 to 7 percent slopes	64	95	35	60	2.0	4.5	25	30	60	90	2.0	4.8
Monona silt loam, 1 to 7 percent slopes, eroded	62	85	34	42	2.0	4.5	22	30	60	85	2.0	4.8
Monona silt loam, 7 to 11 percent slopes	60	85	34	42	1.0	3.5	22	30	50	85	2.0	4.5
Monona silt loam, 7 to 11 percent slopes, eroded	58	75	30	40	1.5	3.5	20	28	50	85	2.0	4.5
Monona silt loam, 11 to 17 percent slopes	48	70	25	40	1.25	2.0	------	------	45	72	1.7	3.3
Monona silt loam, 11 to 17 percent slopes, eroded	40	65	20	35	1.0	2.0	------	------	40	70	.8	3.0
Monona silt loam, 17 to 31 percent slopes [2]	------	------	------	------	------	------	------	------	------	------	------	------
Moody fine sandy loam, 7 to 11 percent slopes	50	75	30	35	2.0	3.0	22	30	50	85	2.0	4.5
Moody silty clay loam, 0 to 1 percent slopes	70	100	38	60	3.0	5.0	30	40	65	95	2.5	5.0
Moody silty clay loam, 1 to 7 percent slopes	65	97	30	58	3.0	4.5	30	38	62	92	2.4	4.9
Moody silty clay loam, 1 to 7 percent slopes, eroded	60	85	34	45	2.0	4.5	22	30	60	85	2.0	4.8
Moody silty clay loam, 7 to 11 percent slopes	60	85	34	42	2.0	3.0	22	30	55	85	2.0	4.5
Moody silty clay loam, 7 to 11 percent slopes, eroded	58	80	30	40	2.0	3.5	20	28	50	85	2.0	4.5
Nora silt loam, 1 to 7 percent slopes, eroded	60	95	34	48	3.0	4.5	24	31	60	95	1.3	4.0
Nora silt loam, 7 to 11 percent slopes	55	80	30	40	1.0	3.5	20	30	50	85	1.3	4.0
Nora silt loam, 7 to 11 percent slopes, eroded	52	75	30	38	1.5	3.5	18	28	48	82	1.3	4.0
Nora silt loam, 11 to 17 percent slopes	45	70	20	32	1.5	3.0	------	------	46	70	1.1	3.0
Nora silt loam, 11 to 17 percent slopes, eroded	40	68	20	30	1.5	3.0	------	------	40	70	1.1	3.0
Nora silt loam, 17 to 31 percent slopes, eroded [2]	------	------	------	------	------	------	------	------	------	------	------	------
Onawa silty clay	65	90	20	42	3.0	4.0	24	36	60	85	2.5	5.0
Onawa and Haynie soils	60	85	20	30	3.0	4.0	24	36	60	80	2.5	4.5
Ortello fine sandy loam, 2 to 5 percent slopes	25	52	21	45	2.0	3.5	20	25	50	60	1.5	5.0
Ortello fine sandy loam, 5 to 11 percent slopes, eroded	20	50	20	45	2.0	3.5	20	25	47	60	1.5	4.0
Riverwash	------	------	------	------	------	------	------	------	------	------	------	------
Rough broken land [3]	------	------	------	------	------	------	------	------	------	------	------	------
Sarpy soils	20	40	10	20	------	------	10	20	------	------	1.7	2.5
Silty alluvial land	------	------	------	------	------	------	------	------	------	------	------	------
Steinauer soils, 11 to 30 percent slopes [2]	------	------	------	------	------	------	------	------	------	------	------	1.0

See footnotes at end of table.

TABLE 2.—*Predicted average acre yields of principal crops*—Continued

Mapping unit	Corn A	Corn B	Oats A	Oats B	Alfalfa hay A	Alfalfa hay B	Soybeans A	Soybeans B	Grain sorghum A	Grain sorghum B	Brome and alfalfa pasture A	Brome and alfalfa pasture B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Animal-unit-month* [1]	*Animal-unit-month* [1]
Thurman loamy sand, 1 to 7 percent slopes	30	45	20	30	.5	1.0			35	50	.6	1.0
Thurman soils, 7 to 17 percent slopes	15	35	10	25	.5	1.0					.5	1.0
Wet alluvial land [2]												
Zook silty clay loam	65	100	25	42	3.0	5.0	25	40	60	110	2.6	4.5
Zook silty clay	60	85	20	40	3.0	5.0	20	35	60	86	2.6	4.5

[1] Animal-unit-month is a term used to express the carrying capacity of pasture. It is the number of animal units, or 1,000 pounds of live weight, that can be grazed on an acre of pasture for a period of 30 days.

[2] Suited to permanent vegetation.

[3] Suited to use as wildlife habitat.

[4] All of the acreage is in native grass.

Management of the Soils for Range[3]

Only a small acreage in Thurston County is still covered by native grasses that are grazed. The soils used as range are in small tracts that generally are not suitable for cultivation. Managing the range so that the reserves of feed and grass are used to their best advantage is important to the success of the rangeland program.

Range Sites and Condition Classes

The kinds of grass that grow on a certain site depend on the kinds of soil. The farmer needs to know the kinds of soil in his holdings and the plants each kind is capable of growing. Then he can manage the range to favor the growth of the best forage plants on each kind of soil.

A range site is a distinctive kind of range that produces a kind and amount of climax vegetation significantly different from that on other sites. A significant difference is one that is large enough to require different grazing use or management to maintain or improve the vegetation. *Climax* vegetation is the combination of plants that originally grew on a given site. The most productive combination of forage plants on a site generally is the climax type of vegetation.

Vegetation is altered by intensive grazing. Livestock graze selectively. They constantly seek the more palatable and nutritious plants. Climax plants react to grazing by decreasing or increasing in number. The *decreasers* are the plants most heavily grazed; they therefore are the first to be injured by overgrazing. The *increasers* either withstand grazing better or are less palatable to the livestock; they increase under grazing and replace the decreasers. If heavy grazing continues, the increasers eventually decrease and are replaced by invaders. *Invaders* are plants not in the original plant community that begin growing when the decreasers and increasers have been weakened or eliminated.

[3] By PETER N. JENSEN, range conservationist, Soil Conservation Service.

Range condition is the present state of the vegetation in relation to the climax conditions for the site. Four range condition classes are defined. A range in excellent condition has present from 76 percent to 100 percent of the vegetation characteristic of the climax vegetation on the same site; one in good condition, 51 to 75 percent; one in fair condition, 26 to 50 percent; and one in poor condition, less than 25 percent.

Descriptions of Range Sites

In the pages that follow, the range sites in the county are discussed and the principal grasses on these range sites are named. These grasses are those that are on the site when it is in excellent condition. Also given for each site is the annual yield of forage when the site is in excellent condition. These yields can be expected to vary according to the rainfall received each year. Past grazing and damage by rodents and insects also affect the annual yields. The names of the soils in each site are in the "Guide to Mapping Units" at the back of this survey.

Wet Land range site

Only Wet alluvial land is in this range site. This land type consists of nearly level soil material on bottom lands and in depressions. The soil material varies in texture and in depth, and in places it is calcareous. The water table is at the surface or to a depth of 3 feet for most of the year, but it is above the surface early in the growing season.

The principal grasses on this range site when it is in excellent condition are big bluestem, indiangrass, prairie cordgrass, switchgrass, and sedges.

The total annual yield of air-dry forage on this range site normally is 7,000 pounds per acre, but yield ranges from 6,500 pounds per acre in unfavorable years to 7,500 pounds in favorable years.

Subirrigated range site

This site consists of nearly level soils on bottom lands or in depressions. These soils have a moderately high

water table that rarely covers the surface but remains within the root zone during the growing season. The soils vary in texture and in depth, and in places they are calcareous.

The principal grasses on this range site when it is in excellent condition are big bluestem, indiangrass, prairie cordgrass, switchgrass, and members of the sedge family.

The total annual yield of air-dry forage on this range site normally is 6,000 pounds per acre, but yield ranges from 5,500 pounds per acre in unfavorable years to 7,500 pounds in favorable years.

Silty Overflow range site

This site consists of nearly level soils on bottom lands that have been flooded. These soils receive additional water from periodic overflow or from runoff. The surface layer and subsoil range from very fine sandy loam to silty clay loam in texture.

The principal grasses on this range site when it is in excellent condition are big bluestem, switchgrass, indiangrass, porcupinegrass, and western wheatgrass.

The total annual yield of air-dry forage on this range site normally is 4,500 pounds per acre, but yield ranges from 4,500 pounds per acre in unfavorable years to 5,500 pounds in favorable years.

Clayey Overflow range site

This site consists of nearly level soils on bottom lands. These soils are subject to flooding and also receive runoff from higher areas. Runoff is slow, and internal drainage is poor. The surface layer ranges from silt loam to clay, and the subsoil from very fine sandy loam to clay.

The principal grasses on this range site when it is in excellent condition are big bluestem, switchgrass, indiangrass, and western wheatgrass.

The total annual yield of air-dry forage on this range site normally is 4,300 pounds per acre, but yield ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

Sandy Lowland range site

This site consists only of Sarpy soils. These soils are nearly level and are on bottom lands. They receive additional beneficial moisture from the water table, which is at a depth between 5 and 8 feet, or from periodic overflow. The surface layer ranges from very fine sandy loam to loamy sand, and the subsoil from sandy loam to fine sand.

The principal grasses on this range site when it is in excellent condition are indiangrass, big bluestem, switchgrass, little bluestem, and prairie sandreed.

The total annual yield of air-dry forage on this range site normally is 4,400 pounds per acre, but yield ranges from 4,000 pounds per acre in unfavorable years to 5,000 pounds in favorable years.

Silty Lowland range site

This site consists of soils on bottom lands and terraces that seldom are flooded. These soils receive additional moisture from runoff from higher areas. Their surface layer and subsoil range from very fine sandy loam to silt loam.

The principal grasses on this range site when it is in excellent condition are big bluestem, indiangrass, switchgrass, little bluestem, and western wheatgrass.

The total annual yield of air-dry forage on this range site normally is 4,500 pounds per acre, but yield ranges from 4,000 pounds per acre in unfavorable years to 5,500 pounds in favorable years.

Sands range site

Only Thurman soils, 7 to 17 percent slopes, is in this site. Moisture is stored deep in these sloping to moderately steep soils, but it is readily given up to plants. The surface layer and subsoil range from loamy sand to sand. These soils are subject to severe soil blowing unless a cover of vegetation is kept on the areas.

The principal grasses on this range site when it is in excellent condition are sand bluestem, switchgrass, little bluestem, and prairie sandreed.

The total annual yield of air-dry forage on this range site normally is 3,500 pounds per acre, but yield ranges from 3,000 pounds per acre in unfavorable years to 4,000 pounds in favorable years.

Sandy range site

This site consists of gently sloping to moderately sloping soils on uplands. The surface layer ranges from fine sandy loam to loamy sand, and the subsoil from loamy fine sand to silty clay loam. Some areas are eroded.

The principal grasses on this range site when it is in excellent condition are big bluestem, little bluestem, switchgrass, indiangrass, and prairie sandreed.

The total annual yield of air-dry forage on this range site normally is 3,400 pounds per acre, but yield ranges from 3,000 pounds per acre in unfavorable years to 4,000 pounds in favorable years.

Silty range site

This site consists of nearly level to steep soils on uplands. The surface layer ranges from silt loam to silty clay loam, and the subsoil from silt loam to light silty clay. Many areas are eroded.

The principal grasses on this range site when it is in excellent condition are big bluestem, little bluestem, indiangrass, switchgrass, and side-oats grama.

The total annual yield of air-dry forage on this range site normally is 3,800 pounds per acre, but yield ranges from 3,500 pounds per acre in unfavorable years to 4,500 pounds in favorable years.

Limy Upland range site

This site consists of nearly level to steep soils on uplands and foot slopes. These soils are well drained. The surface layer and subsoil range from silt loam to silty clay loam in texture. These soils are slightly calcareous to strongly calcareous at or near the surface and in the subsoil. Most of the soils are eroded.

The principal grasses on this range site when it is in excellent condition are little bluestem, big bluestem, side-oats grama, switchgrass, and indiangrass.

The total yield of air-dry forage on this range site normally is 2,800 pounds per acre, but it ranges from 2,000 pounds per acre in unfavorable years to 4,000 pounds in favorable years.

Principles of Range Management

The chief objectives in managing range are maintaining production in the areas in good or excellent condition and increasing production in the areas where the forage has been depleted. Practices therefore are needed that conserve soil and water and that encourage the growth of better native plants.

Grazing practices that maintain or improve the condition of the range are needed on all rangeland in the county. These practices are (1) proper range use, (2) deferred grazing, and (3) rotation-deferred grazing. Livestock can be distributed better and more uniform grazing obtained by correctly locating fences; by developing watering places, such as ponds and wells; and by placing salt in areas where grazing is desired.

On some sites the condition of the range can be improved by range seeding. This improvement can be obtained by seeding improved grasses or by seeding grasses of either wild or improved strains on soils suitable for range. Crofton silt loam, 17 to 31 percent slopes, eroded, and Nora silt loam, 17 to 31 percent slopes, eroded, are examples of soils that are still being cultivated but that should be seeded to grasses. Suitable grasses for these soils are big bluestem, little bluestem, indiangrass, switchgrass, and side-oats grama. On all areas grazing needs to be controlled to maintain a suitable composition of forage plants.

Woodland and Windbreaks[4]

The native trees in Thurston County grow only along the main drainageways. Most of them are on the bluffs and bottom lands near the Missouri River. The trees have little commercial value other than for the fenceposts and small poles they provide.

On the bluffs the woodland is made up of bur oak, red oak, walnut, basswood, and scattered less important trees (fig. 16). The trees here have definite economic potential. Under proper management, the trees could produce a considerable volume of valuable wood for veneer and sawtimber. The stands could be improved by cutting to remove mature, cull, and weed trees. In this way room for good growing stock of such valuable species as walnut and basswood would be provided. The stands also should be protected from fire and from grazing livestock. Cutting good trees for fuelwood because they are convenient to roads also should be prohibited. An estimated annual increase of 200 board feet per acre could be obtained under good management.

Cottonwoods, elms, willows, and other trees that tolerate wetness grow on the bottom lands. These areas have a greater growth potential than those on the bluffs. The kinds of trees that make up the woodland, however, have much less commercial value.

Flood-control devices now protect areas along the river, and it is likely that some of the wooded areas will be cleared and used for crops. Much of the timber has already been removed. The stands on the bottom lands can be improved by encouraging growth of cottonwoods and discouraging growth of elms and willows. Introducing such desirable trees as walnut is desirable if the site is suited.

***Figure 16.*—Mixed hardwoods on a Monona silt loam near lookout tower. (*Courtesy of Bureau of Indian Affairs.*)**

Native woodland in the rest of the county is restricted to a scattering of trees in the valleys. Most of the trees are cottonwood, elm, and other trees of low value.

Most trees that are planted in the county are planted for the purpose of establishing windbreaks or landscape plantings. Many of the windbreak plantings have been made in the last 20 to 30 years (fig. 17).

Windbreaks reduce the cost of heating the farm home, control drifting snow, and protect livestock and farm buildings. They also encourage wildlife (including songbirds) to live in the area and improve the appearance of the farmstead.

***Figure 17.*—Farmstead windbreak of ponderosa pine, about 15 years old, on a Moody silty clay loam.**

[4] By George Alley, woodland conservationist, Soil Conservation Service.

In establishing a windbreak, healthy seedlings of adapted trees should be planted in a well-prepared site. Careful attention is needed in maintaining seedlings to obtain good survival of the young plants (fig. 18).

The rate of growth of trees in a windbreak planting varies, depending upon the kinds of soils and kinds of trees planted. Available moisture, fertility, texture, and depth are characteristics that affect growth. Rainfall, exposure, and arrangement of trees and shrubs within the windbreak also affect growth. Some trees, cottonwood for example, grow fast but do not live long. Siberian elm also grows fast but it spreads to areas where it is not wanted. Because of its susceptibility to Dutch elm disease, American elm is a poor risk.

Such conifers as redcedar, ponderosa pine, Austrian pine, and Rocky Mountain juniper are most desirable for windbreak plantings. Many broadleaf trees and shrubs also can be used. In many windbreaks the faster growing but less desirable broadleaf trees are removed from the shelterbelt when the conifers have reached effective height.

Redcedar grows about a foot a year. At maturity it generally has a height of 30 to 40 feet. Pines and broadleaf trees generally grow faster than redcedar and are somewhat taller.

Information on the design, planting, and care of windbreaks is available from local technicians in the Soil Conservation Service and the Extension Service.

The soils of Thurston County have been grouped according to characteristics that affect the growth of trees. The windbreak group to which each soil belongs is shown at the end of each soil description in the section "Descriptions of the Soils" and is listed in the "Guide to Mapping Units" at the back of this publication. All of the soils in the same windbreak group have about the same capacity for supporting trees. These groups are briefly described in the paragraphs that follow, and trees and shrubs suitable for planting on the soils of each group are listed.

Silty to clayey windbreak suitability group

This group consists of deep, moderately well drained to well drained soils that have a silty to clayey surface layer and subsoil. Trees suitable for planting are eastern redcedar, ponderosa pine, Austrian pine, Scotch pine, Colorado blue spruce, white pine, Norway spruce, honeylocust, green ash, hackberry, bur oak, red oak, Russian mulberry, and Russian-olive. Suitable shrubs are cotoneaster, lilac, honeysuckle, Nemaha plum, chokecherry, three-leaved sumac, and autumn olive.

Figure 18.—**Newly planted trees in a Moody silty clay loam that have been clean cultivated.**

Moderately wet windbreak suitability group

This group consists of soils on bottom lands and in upland valleys. These soils are moderately wet at times because of a high water table or short, frequent floods. Trees suitable for planting are eastern redcedar, Scotch pine, Black Hills spruce, Austrian pine, green ash, honeylocust, hackberry, cottonwood, golden willow, white willow, black walnut, sycamore, diamond willow, and Russian-olive. Suitable shrubs are purple willow, red-osier dogwood, buffaloberry, and chokecherry.

Sandy windbreak suitability group

This group consists of fine sandy loams to loamy sands that are well drained to excessively well drained. Trees suitable for planting are eastern redcedar, ponderosa pine, Austrian pine, Scotch pine, green ash, honeylocust, and cottonwood. Suitable shrubs are honeysuckle, Nemaha plum, American plum, and three-leaved sumac.

Wet windbreak suitability group

This group consists of silty and alluvial material on bottom lands. The areas are extremely wet because of a high water table, very poor drainage, or frequent flooding. Trees suitable for planting are cottonwood, golden willow, white willow, and diamond willow. Conifers are not suited. Suitable shrubs are purple willow and red-osier dogwood.

Undesirable windbreak suitability group

This group consists of land types that are variable in texture. Range of slopes and topography is wide. The areas are too steep or sandy for planting trees with machinery or are too wet for good survival and growth of trees and shrubs.

These land types generally are not suited to windbreak plantings, but some areas support a limited cover of trees. Some of the areas can be used for recreational purposes and for planting trees or shrubs to provide food and cover for wildlife if the plants are planted by hand or if other special practices are used.

Wildlife and Recreation [5]

The kinds and amounts of wildlife that can be produced in the county depend largely upon the soils and the kinds and amounts of vegetation they can produce. Wildlife is influenced by relief and by such soil characteristics as fertility, permeability, and drainage. Fertile soils produce more wildlife than less fertile soils, and the species generally are larger and more vigorous. Also, the waters that drain from fertile soils generally produce more fish than those that drain from infertile soils.

[5] By C. V. Bohart, conservation biologist, Soil Conservation Service.

Relief affects wildlife through its influence on land use. Rough, irregular areas are likely to be hazardous to livestock, but the vegetation in such areas may be valuable for wildlife. If suitable vegetation is lacking, such areas generally can be developed to provide the kind of vegetation needed by desirable kinds of wildlife.

Wetness and water-holding capacity of the soils are important in selecting sites for building ponds for fish and in maintaining habitats for waterfowl. Marshes and other wet areas are suitable for developing habitats for waterfowl and for some furbearers.

The wildlife in the county are important mainly for the recreational opportunities they provide. In this subsection use of the soils for such purposes is discussed in relation to the soil associations in the county. The soil associations are shown on a colored soil map at the back of this survey and are described in the section "General Soil Map."

The potential of the soil associations in the county for producing habitats for different kinds of wildlife is given in table 3. Ratings of *very good* and *good* in the table take into account the kinds of soil in each association and their potential (shown in the column titled "Food") for producing the kind of vegetation needed for openland, woodland, and wetland wildlife.

Openland wildlife are mammals and birds that live in and around cropland, pasture, meadow, and odd areas of herbaceous vegetation. Examples in Thurston County are pheasant, quail, meadowlarks, cottontail rabbit, coyote, and badger. *Woodland wildlife* are mammals and birds that normally live in areas of trees and shrubs or that require a large amount of this kind of habitat. Examples are white-tailed deer, squirrel, raccoon, and thrushes. *Wetland wildlife* are birds and mammals that normally frequent ponds, marshes, rivers, streams, swamps, and other wet areas. Examples are ducks, shore birds, beaver, mink, and muskrat.

In the Moody-Nora-Thurman association and in the Moody-Nora-Judson association, the soils are gently sloping to moderately steep and are productive. These soils provide an abundant supply of waste grain for wildlife. Many pheasant are in these two associations, and suitable habitat is available for cottontail rabbit, deer, quail, and many other small mammals and songbirds.

Odd areas of such natural wildlife cover as shrubs, trees, and native herbaceous plants are scarce in these two soil associations because the soils and relief permit use of most of the acreage for crops. Nesting cover for pheasant and other birds that nest on the ground is scarce. Planting field and farmstead windbreaks provides some woody cover for wildlife. Seeding borders around fields used for crops helps to provide nesting cover for birds that nest on the ground. If odd areas are available, the natural plants growing in the areas require protection from livestock. Mowing grassed waterways and areas along the sides of roads after the peak of the hatching season also saves many birds.

The soils in the Judson-Kennebec-Lamo association border natural waterways and provide some woody cover for such wildlife as mink, muskrat, and beaver. Some habitat also is available for quail. In addition the woodland along the streams provides suitable habitat for squirrel, cottontail rabbit, deer, and songbirds. The streams provide fair habitat for fish, and waterfowl use the streams as resting areas during migrations. Pheasant also frequent this association in fair to good numbers.

The Monona-Ida association includes bluffs along the Missouri River. Trees that provide excellent habitat for deer cover a fairly large part of the bluffs. The habitat here also is suitable for squirrel, birds, and other woodland wildlife. Other parts of this association are suitable for such game birds as quail and pheasant. In addition the timber and unique topography of the bluffs overlooking the Missouri River give the Monona-Ida soil association good potential for developing facilities for outdoor recreation.

The Albaton-Haynie association, on bottom lands in the eastern part of the county, is bordered by the Missouri River. Many kinds of sport fish are taken in this river. Among the fish taken are yellow and blue catfish, bass, crappie, sauger, and walleyed pike. Commercial fishing is also an enterprise in the Missouri River. Sloughs and backwater areas in the association provide good habitat for

TABLE 3.—*Potential of the soil associations for producing habitats for different kinds of wildlife*

[Dashes indicate that potential for habitat requirement does not occur in the association specified]

Soil association	Wildlife	Potential for—			
		Woody cover	Herbaceous cover	Food	Aquatic environment
Moody-Nora-Thurman	Openland	Very good	Very good	Very good	---
Moody-Nora-Judson	Woodland	Very good	Very good	Very good	---
Judson-Kennebec-Lamo	Openland	Very good	Very good	Very good	---
	Woodland	Very good	Very good	Very good	---
	Wetland	Good	Good	Good	Good.
	Fish	---	---	---	Good.
Monona-Ida	Openland	Very good	Very good	Very good	---
	Woodland	Very good	Very good	Very good	---
Albaton-Haynie	Openland	Very good	Very good	Very good	---
	Woodland	Very good	Very good	Very good	---
	Wetland	Very good	Very good	Very good	Very good.
	Fish	---	---	---	Very good.

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waterfowl, shore birds, and such furbearers as muskrat and mink. Excellent habitat also is available for deer in tracts where shrubs and trees have not been cleared. Crops grown in the Albaton-Haynie association provide a supply of grain for use as food by a few quail and pheasant and other kinds of wildlife.

Developing habitat for wildlife requires proper location and distribution of the kind of vegetation that the soils can produce. Technical assistance in planning wildlife developments and the kind of management needed can be obtained from local technicians of the Soil Conservation Service and the Extension Service. Additional information and assistance can be obtained from the Nebraska Game, Forestation, and Parks Commission, and the U.S. Bureau of Sports, Fisheries, and Wildlife.

In planning use of any area for outdoor recreation, technical assistance can be obtained from the Soil Conservation Service and Bureau of Indian Affairs in planning and applying conservation practices for developing the facilities needed.

Engineering Uses of the Soils [6]

Some soil properties are of special interest to engineers because they affect the construction and maintenance of highways and roads, airports, pipelines, building foundations, facilities for storing water and controlling erosion, and systems for irrigating and draining soils and for disposing of sewage. Among the properties most important to engineers are soil texture, permeability, shear strength, plasticity, reaction, and available water capacity. Also important are relief, depth to the water table, and depth to bedrock or to sand or gravel.

The information in this survey can be used by engineers to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, businesses, and residences, and for recreational areas.
2. Make estimates of engineering properties of soils that will help in the planning of agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for conserving soil and water.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, cables, and sewage disposal fields and in planning more detailed investigations at selected locations.
4. Estimate the size of drainage areas and the speed and volume of runoff for use in designing culverts and bridges.
5. Identify the soils along the proposed routes for highways for use in making preliminary estimates of the thickness required for flexible pavements.
6. Locate deposits of sand, gravel, rock, mineral filler, and soil binder for use in constructing subbase courses, base courses, and surface courses of flexible pavements.
7. Estimate the amount of clay needed to stabilize the surface of unpaved roads.
8. Make preliminary evaluations of the topography, surface drainage, subsurface drainage, height of water table, and other features that affect the design of highway embankments, subgrades, and pavements.
9. Correlate performance of engineering structures with soil mapping units and thus develop information that can be used in designing and maintaining these structures.
10. Determine the suitability of the soils for cross-country movement of vehicles and construction equipment.
11. Supplement information obtained from other published maps and surveys and from aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
12. Develop other preliminary estimates for construction purposes pertinent to the area.

Used with the soil map to identify the soils, the engineering interpretations in this subsection are useful for many purposes. It should be emphasized, however, that the interpretations made in this soil survey are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work that involves heavy loads or at a site where excavations are to be deeper than the depths of the layers here reported. Even in such situations, the soil map is useful for planning more detailed field investigations and for suggesting the kind of problems that can be expected.

The soil mapping units shown on the maps in this survey may include small areas of a different soil material. These included soils may be as much as 2 acres in size. They are too small to be mapped separately and generally are not significant to the farming in the area but may be important in engineering planning.

Information of value in planning engineering work is given throughout the text, particularly in the sections "Descriptions of the Soils" and "Formation and Classification of Soils."

Some of the terms used by the scientist may be unfamiliar to the engineer, and some words—for example, clay, sand, and silt—may have special meaning in soil science. These and other special terms used in the soil survey are defined in the Glossary at the back of this survey. Most of the information about engineering is given in tables 4, 5, and 6.

Engineering Classification Systems

Two systems of classifying soils are in general use by engineers. One is the system used by the American Association of State Highway Officials (AASHO) (*1*), and the other is the Unified system, which was developed by the Corps of Engineers, U.S. Department of Defense (*10*). Estimated classifications of all the soils according to these two systems and according to the textural classification used by the U.S. Department of Agriculture are shown in table 5.

The AASHO system is based on field performance and on gradation, liquid limit, and plasticity index. In this system soils are placed in seven groups, ranging from A–1 through A–7. Soils in the A–1 group are gravelly and have

[6] This subsection was prepared by HENRY E. BERGSCHNEIDER, area engineer, and NORMAN L. SLAMA, soil scientist, assisted by LEE E. SMEDLEY, assistant State conservation engineer; all of Soil Conservation Service.

high bearing capacity; those in the A-7 group are clayey and have low bearing capacity when wet. The relative engineering values of the soils within each group are indicated by a group index number. Group index numbers range from 0 for the best material to 20 for the poorest. The group index of a soil can be established only by laboratory tests. The AASHO classifications in table 4 include group index numbers for the tested soils.

The Unified system is based on the texture and plasticity of the soils, as well as on their performance. Three soil fractions are recognized—gravel, sand, and fines (silt and clay). Soils are classified as coarse grained (eight classes), fine grained (six classes), and highly organic (one class) according to their content of the three soil fractions. A letter symbol indicates the principal characteristics of the soils. The coarse-grained soils are gravel (G) and sand (S), and each of these is divided into four secondary groups. The fine-grained soils are silt (M) and clay (C), depending on their liquid and plasticity index. The silt and clay groups are each divided into secondary groups according to whether the soils have low (L) or high (H) liquid limit. The highly organic soils (Pt) generally are very compressible and have undesirable characteristics for construction purposes.

Engineering Test Data

Table 4 gives engineering test data for 10 soil types tested for this survey. The samples taken were of natural horizons. They were tested by the Division of Materials and Tests, Nebraska Department of Roads, according to standard procedures.

Each soil type listed in table 4 was sampled at only one location, and the data given for the soil are those at that location. From one location to another, a soil may differ considerably in characteristics that affect engineering. Even where the soils are sampled at more than one location, the test data probably do not show the widest range in characteristics.

Moisture-density data in table 4 were obtained by mechanical compaction. If soil material is compacted at successively higher moisture content and the compaction effort remains constant, the density of the compacted material increases until the optimum moisture content is reached. After that the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is the maximum dry density. Moisture-density data are important in earthwork, for, as a rule, soil is most stable if it is compacted to the maximum dry density when it is at the optimum moisture content.

The mechanical analysis was made by a combination of the sieve and hydrometer methods. The percentages of clay obtained by the hydrometer method should not be used in naming textural classes of soils. The classifications in the last two columns of table 4 are based on data obtained by mechanical analysis and on tests made to determine liquid and plastic limits.

The tests for liquid limit and plastic limit measure the effect of water on the consistency of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content, expressed as a percentage of the oven-dry weight of the soil, at which the soil material passes from a semisolid to a plastic state. The *liquid limit* is the moisture content at which the material passes from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition. Some silty and sandy soils are nonplastic, that is, they do not become plastic at any moisture content.

Estimated Engineering Properties

In table 5 the soil series of the county and the symbols for mapping units are listed, and certain properties that are significant to engineering are estimated. The estimates are based on the engineering test data in table 4, on other information obtained in the county during the survey, and on knowledge about the same kinds of soils obtained in other areas. The data are listed by layers that have properties significant to engineering. These data include the textural classification of the United States Department of Agriculture and the AASHO and Unified engineering classifications. Also listed for each layer are the percentages of material that will pass a No. 10 sieve and a No. 200 sieve.

In table 5 permeability refers to the rate at which water moves through undisturbed soil material. Permeability depends largely upon the texture and structure of the soil. The rate is listed for each layer of soil in inches of soil permeated per hour. Terms used to describe permeability and their equivalent ratio in inches per hour are as follows: *slow* (0.06 to 0.20), *moderately slow* (0.20 to 0.63), *moderate* (0.63 to 2.0), *moderately rapid* (2.0 to 6.3), *rapid* (6.3 to 20.0), and *very rapid* (more than 20.0).

Available water capacity, expressed in inches of water per inch of soil depth, is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of water in a soil at field capacity and the amount at wilting point.

The rating for shrink-swell potential indicates how much a soil changes in volume when subjected to a change in moisture content. It generally is related to soil texture. In table 5, the shrink-swell potential of plastic silts and clays is rated as *high* and that of nonplastic soils with no potential change in volume is rated as *none*. Soils that are intermediate in content of silt and clay are rated as *low* to *moderate*. The low to moderate ratings of some soils were obtained by comparing the soils with others of known mechanical analysis or plasticity rating.

Engineering Interpretations

The interpretations in table 6 will help engineers and others plan the use of soils in construction. In this table the soils are rated according to their suitability as a source of topsoil and sand. They are also rated according to their suitability for use as subgrade for paved roads and gravel roads and as road fill. In addition, soil features are named that affect highway location, foundations, agricultural practices such as low dams and other small structures, drainage, irrigation, terraces and diversions, and waterways. Also in table 6 are the degree and kinds of limitations if the soils are used as sites for sewage disposal.

Topsoil is fertile soil material that ordinarily is rich in organic matter. It is used to topdress roadbanks,

TABLE 4.—*Engineering*

[Tests performed by the Nebraska Department of Roads in cooperation with U.S. Department of Commerce, Bureau of Public

Soil name [1] and location	Parent material	Nebraska report No.	Depth	Moisture-density [2]	
				Maximum dry density	Optimum moisture
			In.	*Lb. per cu. ft.*	*Pct.*
Albaton silty clay: 0.3 mile E. and 100 feet S. of NW. corner of sec. 28, T. 25 N., R. 10 E.	Recent alluvium.	226 227 228	99–15 15–25 33–48	95 84 93	24 30 27
Crofton silt loam: 2,280 feet S. and 200 feet E. of NW. corner of sec. 5, T. 26 N., R. 8 E.	Peoria loess.	232 233 234	0–7 7–18 18–32	98 102 103	21 20 18
Judson silt loam: 740 feet S. and 520 feet E. of NW. corner of sec. 25, T. 26 N., R. 6 E.	Colluvium and local alluvium.	247 248 249	6–16 16–34 46–54	94 95 95	25 23 23
Kennebec silt loam: 320 feet E. and 175 feet N. of SW. corner of SE¼, sec. 28, T. 26 N., R. 8 E.	Alluvium.	241 242 243	11–20 20–26 26–60	90 93 97	26 25 23
Lamo silty clay loam: 182 feet E. and 90 feet S. of NE. corner of sec. 1, T. 26 N., R. 5 E.	Old alluvium.	220 221 222	7–17 35–54 60–80	94 106 118	22 19 12
Monona silt loam: 156 feet E. and 130 feet S. of NW. corner of sec. 15, T. 26 N., R. 9 E.	Peoria loess.	229 230 231	6–16 16–37 37–50	98 102 103	20 19 19
Moody silty clay loam: 50 feet W. and 0.35 mile S. of NW. corner of sec. 29, T. 26 N., R. 6 E.	Peoria loess.	250 251 252	0–6 16–33 54–70	96 98 103	23 21 19
Moody fine sandy loam: 0.125 mile E. and 250 feet N. of SW. corner of sec. 7, T. 26 N., R. 6 E.	Peoria loess.	244 245 246	0–6 30–44 60–70	113 101 101	15 21 21
Thurman loamy fine sand: 1,800 feet E. and 105 feet N. of the SW. corner of sec. 1, T. 26 N., R. 5 E.	Reworked glacial sand.	223 224 225	0–10 10–20 20–60	127 128 121	10 9 9
Zook silty clay: 800 feet S. and 100 feet W. of NE. corner of sec. 8, T. 25 N., R. 6 E.	Old alluvium.	235 236 237	8–14 14–32 41–60	88 89 93	29 30 28

[1] Profile is modal for the soil type.
[2] Based on AASHO Designation T 99-57 Methods A and C (*1*).
[3] Mechanical analyses according to the AASHO Designation T 88-57 (*1*). Results by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table

gardens, and lawns. The soils in table 6 are rated good, fair, and poor as a source of topsoil. Soils rated poor or fair to poor generally are low in content of organic matter or natural fertility, or they have a surface layer that is heavy and sticky and is difficult to work.

Sand and gravel generally is not available. The soils given ratings that indicate that they are a possible source of sand may require detailed exploration to find sand and to determine its quantity and if the sand meets gradation requirements.

Ratings are listed in table 6 for the suitability of soils as road subgrade for paved roads, either bituminous or concrete, and for gravel roads. Properly confined sand is the best subgrade for paved roads. The soil material is rated *good* if the AASHO classification is A–1 or A–3, *good* to *fair* if A–2, *fair* to *poor* if A–4, and *poor* if A–6 or A–7.

The ratings of the soils as subgrade for gravel roads refer to that part of the subgrade that receives the gravel surfacing. Sand is not cohesive, and unless confined, it does not make good subgrade for gravel roads. Therefore, all soils classified A–1 or A–3 are rated *poor;* A–2, *poor to fair;* A–4, *good to fair;* and A–6 or A–7, *good.*

test data

Roads (BPR), in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [3]								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than—						AASHO [4]	Unified [5]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	*Pct.*			
---------	---------	---------	100	95	90	62	49	62	39	A-7-6(20)	CH
---------	---------	---------	100	97	93	66	50	68	34	A-7-5(20)	MH-CH
---------	---------	---------	100	99	97	70	55	72	46	A-7-6(20)	CH
100	99	99	98	91	62	34	24	44	19	A-7-6(12)	ML-CL
100	99	99	98	91	59	33	24	40	18	A-6(11)	CL
100	99	99	99	92	62	34	24	40	18	A-6(11)	CL
---------	---------	100	99	88	57	30	21	44	16	A-7-6(11)	ML-CL
---------	---------	100	99	92	57	30	23	44	16	A-7-6(11)	ML-CL
---------	---------	---------	100	95	68	44	34	54	28	A-7-6(18)	CH
---------	---------	100	99	92	63	34	23	49	19	A-7-5(13)	ML
---------	---------	---------	100	94	72	42	32	56	28	A-7-6(18)	MH-CH
---------	---------	---------	100	95	72	41	32	53	29	A-7-6(18)	CH
100	99	93	83	80	67	41	32	47	26	A-7-6(16)	CL
100	98	91	77	72	52	32	25	38	21	A-6(12)	CL
100	93	72	44	41	33	23	18	25	12	A-6(2)	SC
---------	---------	---------	100	93	68	38	29	46	23	A-7-6(14)	CL
---------	---------	---------	100	91	60	31	24	42	19	A-7-6(12)	CL
---------	---------	100	99	93	58	29	20	39	16	A-6(10)	CL
---------	100	98	94	86	59	35	26	47	19	A-7-6(13)	ML-CL
---------	---------	100	99	94	64	38	30	51	27	A-7-6(17)	CH
---------	---------	---------	100	90	52	29	25	40	18	A-6(11)	CL
100	95	79	55	51	36	21	18	28	11	A-6(4)	CL
---------	---------	100	99	96	65	43	36	51	27	A-7-6(17)	CH
---------	---------	---------	100	96	64	37	29	49	25	A-7-6(16)	CL
100	59	44	26	20	13	8	7	19	3	A-2-4(0)	SM
[6] 99	48	33	13	10	7	4	3	(7)	(7)	A-1-b(0)	SM
100	45	31	10	9	6	4	3	(7)	(7)	A-1-b(0)	SW-SM
---------	100	99	99	96	89	66	55	72	43	A-7-6(20)	CH
---------	---------	100	99	95	87	67	55	82	53	A-7-6(20)	CH
---------	---------	100	99	98	92	68	55	69	42	A-7-6(20)	CH

are not suitable for use in naming textural classes for soil.

[4] Based on AASHO Designation M 145-49.

[5] SCS and BPR have agreed to consider that all soils having plasticity indexes within 2 points from A-line are to be given a borderline classification.

[6] 100 percent passes a No. 4 sieve.

[7] Nonplastic.

The ratings for road fill are based on about the same criteria as the ratings for road subgrade. Some ratings for paved and gravel roads and for road fill are given as a range because the soil in the profile varies.

Susceptibility to frost action is one of the factors that affects highway location. The ratings for frost action in table 6 are based mainly on texture of the surface layer and subsoil. Clays and silts are susceptible to frost action if the underlying layers are pervious enough for water to rise and form lenses of ice. Many of the soils in the county have a high content of clay and are highly susceptible to frost action.

For foundations, the soils in table 6 are rated for bearing capacity and for susceptibility to liquefaction. The material evaluated is that part of the profile below a depth of 3 feet. The bearing capacity of soils in the county varies widely, and engineers and others should not apply specific values to the estimates given for bearing capacity. Draining or lowering the water table at the site of the foundation may be necessary. All soils that have a high water table should be investigated thoroughly before structures are built on them.

Dikes and levees are used mainly in areas on flood plains. Consequently, only soils on flood plains have been

TABLE 5.—*Estimated engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soil in referring to other series that appear

Soil series and map symbols	Underlying material [1]	Depth to water table	Depth from surface	Classification
				Dominant USDA texture
		Feet	*Inches*	
Albaton:				
Am	Stratified alluvial clay.	5–8	0–10 10–30 30–60	Silty clay loam Silty clay Clay
Ak	Stratified alluvial clay.	5–8	0–48	Silty clay
*Belfore: BM (For properties of Moody soil in this mapping unit, refer to Moody series in this table.)	Silt (Peoria loess).	>20	0–14 14–47 47–60	Silty clay loam Silty clay loam to silty clay. Silt loam
Burchard:				
BnC[2], BnD	Clay (Kansan till).	>20	0–6 6–44 44–60	Silt loam Silty clay to clay loam. Clay loam
BdD2	Clay (Kansan till).	>20	0–8 8–24 24–60	Clay loam Clay loam Clay loam
Colo: Ct	Stratified alluvial silt and clay.	4–10	0–13 13–60	Silty clay loam Silty clay loam
Crofton: CfB2 [2], CfC2, CfD2, CfE2	Silt (Peoria loess).	>20	0–7 7–12 12–60	Silt loam Silt loam Silt loam
Gullied land: GL [3]				
Haynie: He	Stratified alluvial silt and sand.	6–20	0–20 20–60	Silt loam Very fine sandy loam
Ida: IdC2 [2], IdD, IdD2, IdE, IdE2	Silt (Peoria loess).	>20	0–7 7–60	Silt loam Silt loam
Judson: JuA [2], JuB	Colluvial-alluvial silt.	>20	0–6 6–60	Silt loam Silty clay loam
Kennebec: Ke	Alluvial silt and clay.	6–10	0–7 7–26 26–60	Silt loam Silt loam to sily clay loam Silt loam
Lamo:				
2La	Alluvial silt and clay.	4–10	0–20 20–60	Silt loam Silty clay loam
Lb	Alluvial silt and clay.	2–10	0–17 17–35 35–54	Silty clay loam Silty clay loam Silty clay loam
Luton:				
Ls	Alluvial clay.	4–8	0–16 16–60	Silty clay loam Silty clay
Lk	Alluvial clay.	3–6	0–19 19–60	Silty clay Clay to silty clay
Marsh: M[3]	Silt, clay, and sand (very recent stratified alluvium).			
Monona: MnB[2], MnB2, MnC, MnC2, MnD, MnD2, MnF.	Silt (Peoria loess).	>20	0–60	Silt loam

See footnotes at end of table.

properties of the soils

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for in the first column of this table]

Classification—Continued		Percentage passing sieve		Permeability	Available water capacity	Shrink-swell potential
Unified	AASHO	No. 10	No. 200			
				Inches per hour	*Inches per inch of soil*	
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 18	High.
MH or CH	A–7	100	95–100	0. 06–0. 2	0. 16	High.
CH	A–7	----------	100	0. 06–0. 2	0. 15	High.
CH	A–7	----------	100	0. 06–0. 2	0. 15	High.
CL	A–7	100	95–100	0. 2–0. 63	0. 18	Moderate.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 16–0. 18	Moderate to high.
CL	A–6 or A–7	100	95–100	0. 2–0. 63	0. 19	Moderate.
ML or CL	A–4 or A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 17–0. 18	Moderate to high.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 17	Moderate to high.
CL	A–6	100	95–100	0. 2–0. 63	0. 17	Moderate.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 17	Moderate.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 17	Moderate.
CL	A–7	100	95–100	0. 2–0. 63	0. 18	Moderate.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
CL or ML	A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL	A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL or ML	A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL or ML	A–4 or A–6	----------	100	0. 63–2. 0	0. 19	Low to moderate.
ML	A–4	----------	90–100	0. 63–2. 0	0. 18	Low.
ML to CL	A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
ML to CL	A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
ML to CL	A–4 or A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL or CH	A–7	----------	100	0. 63–2. 0	0. 18	Moderate to high.
ML to CL	A–4 or A–6	100	95–100	0. 63–2. 0	0. 19	Low to moderate..
CH	A–7	----------	100	0. 63–2. 0	0. 18	Moderate to high
CH	A–7	----------	100	0. 63–2. 0	0. 18	Moderate to high
ML	A–4	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL	A–6	100	75–100	0. 2–0. 63	0. 18	Moderate to high.
CL	A–7–6	100	80–95	0. 2–0. 63	0. 18	Moderate to high.
CL or CH	A–6	100	80–95	0. 2–0. 63	0. 18	Moderate to high.
CL	A–6	100	75–95	0. 2–0. 63	0. 18	Moderate to high.
CL or CH	A–6 or A–7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
CH	A–7	100	95–100	0. 06–0..2	0. 16	High.
CL or CH	A–6 or A–7	100	95–100	0. 06–0. 2	0. 16	High.
CH	A–7	100	95–100	0. 06–0. 2	0. 16	High.
ML to CL	A–6 or A–7	100	95–100	0. 63–2. 0	0. 19	Low to moderate.

TABLE 5.—*Estimated engineering*

Soil series and map symbols	Underlying material [1]	Depth to water table	Depth from surface	Classification: Dominant USDA texture
		Feet	*Inches*	
Moody: MyC	Silt (Peoria loess).	>20	0–10 10–60	Fine sandy loam Silty clay loam
Mo[2], MoB, MoB2, MoC, MoC2	Silt (Peoria loess).	>20	0–10 10–33 33–54	Silty clay loam Silty clay loam Silty clay loam
McPaul: Mc	Alluvial silt and clay.	8–20	0–6 6–30 30–60	Silt loam Silt loam Silt loam to silty clay loam
Nora: NoB2[2], NoC, NoC2, NoD, NoD2, NoE2	Silt (Peoria loess).	>20	0–10 10–25 25–60	Silt loam Silty clay loam Silt loam
*Onawa: Oc[2], ON (For properties of Haynie soil in unit ON, refer to Haynie series in this table.)	Stratified alluvial silt and clay.	2–7	0–18 18–60	Silty clay Very fine sandy loam
Ortello: OrB[2], OrC2	Wind-laid sand.	>20	0–42 42–60	Fine sandy loam Sand
Riverwash: Rw[3]	Stratified sand.	3–10		
Rough broken land: BLg[3]	Silt (Peoria loess).			
Sarpy: Sb	Stratified alluvial sand.	5–15	0–7 7–60	Very fine sandy loam Fine sand
Silty alluvial land: Sy[3]	Stratified alluvial silt.	6–15		
Steinauer: StE	Silt and clay (Kansan till).	>20	0–4 4–42	Silty clay loam or clay loam Clay loam
Thurman: TcB	Wind-laid sand.	>20	0–16 16–28 28–60	Loamy sand Loamy sand Sand
TxE	Wind-laid sand.	>20	0–7 7–15 15–60	Loamy sand Loamy sand Sand
Wet alluvial land: Wx	Stratified alluvial silt and clay.	1–3	0–40	Silty clay loam
Zook: Zo	Alluvial clay.	6–12	0–16 16–60	Silty clay loam Clay
Zc	Alluvial clay.	6–12	0–14 14–60	Silty clay Clay

[1] Generally at a depth between 4 and 10 feet.

[2] Classification and properties are those of this phase; the other phases of this series are nearly uniform in properties listed except for runoff and as indicated by soil name, degree of erosion, or alkalinity (in very small areas.)

properties of the soils—Continued

Classification—Continued		Percentage passing sieve		Permeability	Available water capacity	Shrink-swell potential
Unified	AASHO	No. 10	No. 200			
				Inches per hour	*Inches per inch of soil*	
CL or ML	A-4 or A-6	100	50–65	2. 0–6. 3	0. 16	Low.
CL or CH	A-7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
ML to CL	A-6 or A-7	100	90–95	0. 2–0. 63	0. 18	Moderate.
CH	A-7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
CH or CL	A-6 or A-7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
ML	A-6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
ML to CL	A-4 or A-6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL	A-6	100	95–100	0. 63–2. 0	0. 18–0. 19	Moderate.
ML or CL	A-6	100	95–100	0. 63–2. 0	0. 19	Low to moderate.
CL	A-6 or A-7	100	90–100	0. 63–2. 0	0. 18	Moderate.
ML or CL	A-6	100	90–100	0. 63–2. 0	0. 19	Low to moderate.
CH	A-7	----------	100	0. 06–0. 2	0. 16	High.
ML to CL	A-4 to A-6	100	50–60	0. 63–2. 0	0. 18	Low.
SM	A-4	100	34–45	2. 0–6. 3	0. 16	Low.
SP-SM or SM	A-3 or A-2	100	8–20	6. 3–20. 0	0. 10	Very low to none.
ML to CL	A-4 to A-6	100	50–65	0. 63–2. 0	0. 16	Low.
SP or SP-SM	A-3	100	5–12	6. 3–20. 0	0. 06–0. 08	Very low to none.
CL	A-6	[4] 85–95	75–90	0. 2–0. 63	0. 18	Moderate.
CL or CH	A-6 or A-7	[4] 85–95	75–90	0. 2–0. 63	0. 17	Moderate to high.
SM	A-2	[5] 80–90	20–25	6. 3–20. 0	0. 10	Low.
SM	A-1	[5] 85–95	12–16	6. 3–20. 0	0. 10	Low to none.
SW	A-1	[5] 90–96	8–12	6. 3–20. 0	0. 06–0. 08	Low to none.
SM	A-2	100	20–30	6. 3–20. 0	0. 10	Very low to none.
SP-SM or SM	A-3 or A-2	[5] 95–100	10–15	6. 3–20. 0	0. 10	Very low to none.
SP-SM	A-3 or A-2	100	8–12	6. 3–20. 0	0. 06–0. 08	Very low to none.
CL or CH	A-6 or A-7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
CL or CH	A-6 or A-7	100	95–100	0. 2–0. 63	0. 18	Moderate to high.
CH	A-7	100	95–100	0. 06–0. 2	0. 15	Moderate.
CH	A-7	100	95–100	0. 06–0. 2	0. 16	Moderate.
CH	A-7	100	95–100	0. 06–0. 2	0. 15	Moderate.

[3] Properties too variable to estimate.
[4] 95 to 100 percent passes the No. 4 sieve.
[5] 100 percent passes the No. 4 sieve.

TABLE 6.—*Engineering*

[Not included in this table, because their characteristics are too variable to be estimated, are Gullied land (GL), Marsh (M), Riverwash applicable. An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. instructions for referring to other series that appear in the first column of this table]

Soil series and map symbols	Suitability as source of—				Soil properties affecting—			
	Topsoil	Sand	Road subgrade		Road fill	Highway locations	Foundations	Dikes and levees
			Paved	Gravel				
Albaton: Am, Ak	Poor		Poor	Good	Poor	High susceptibility to frost action; erodibility of slopes; subject to occasional flooding; 4 to 7 feet of fill required; ponding of water on surface.	Poor bearing capacity; poor shear strength.	Erodibility of slopes; cracks when dry.
*Belfore: BM (For interpretations of Moody soil in this mapping unit, refer to Moody series in this table.)	Good		Poor	Good	Fair to poor.	High susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	
Burchard: BnC, BnD, BdD2.	Fair		Poor	Good	Poor to fair.	High susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	
Colo: Ct	Good		Poor	Good	Poor to fair.	Moderate to high susceptibility to frost action; susceptibility to ponding and flooding; high water table; 4 to 7 feet of fill required in places; erodibility of slopes.	Fair to poor bearing capacity; wet in places.	Erodibility of slopes; may crack when dry.
Crofton: CfB2, CfC2, CfD2, CfE2.	Fair		Poor	Good	Fair to poor.	High erodibility of embankment slopes; high cuts and fills needed in places; high susceptibility to frost action.	Fair to poor bearing capacity.	

interpretations

(Rw), Rough broken land (BLg), and Silty alluvial land (Sy). Absence of information indicates practice not suitable or generally not
The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the

Soil properties affecting—Continued					Soil limitations for sewage disposal		
Low dams		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tanks filter fields	Sewage lagoons
Reservoir area	Embankment						
Low seepage; suitable for dugouts in places.	Fair to poor stability; impervious; poor workability; plastic.	Subject to occasional flooding; slow internal drainage; water ponds on surface; suitable outlets not available in places.	High available water capacity; adequate drainage necessary; slow intake rate.	--------------	Clayey; poor workability; wet in places.	Severe: slow permeability; water table.	Slight: in places protection from flooding needed.
Generally low seepage.	Fair to good stability; slopes erodible.	Well drained to moderately well drained.	High available water capacity.	Erodibility of diversion slopes.	Moderate erodibility.	Severe: moderately slow permeability.	Slight.
Low seepage---	Good to fair stability; good to fair workability; impervious; medium to high compressibility.	Well drained----	High available water capacity; erodibility of slopes.	Erodibility---	High erodibility where subsoil is exposed; vegetation may be difficult to establish.	Severe: moderately slow permeability; strong slopes.	Severe: strong slopes.
Low seepage; may be used for dugouts.	Fair to good stability; fair to poor workability.	Slow surface and internal drainage; subject to overflow; adequate outlets may not be available; high water table in places.	High available water capacity; slow intake rate; adequate drainage is necessary.	--------------	May have seepage or wet areas; moderate erodibility.	Severe: subject to flooding; water table at a depth of 4 to 10 feet.	Moderate: may require sealing and protection from flooding.
Moderate seepage.	Fair to poor stability; fair to good workability; foundation drains may be necessary; requires close control.	Good internal drainage; runoff excessive.	High available water capacity; high erodibility of slopes.	Erodibility; steep and irregular slopes make alinement difficult.	High erodibility; maintenance costs may be high; steep slopes.	Moderate on slopes of less than 10 percent. Severe on slopes of more than 10 percent.	Severe: slopes; moderate permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—					Soil properties affecting—		
	Topsoil	Sand	Road subgrade		Road fill	Highway locations	Foundations	Dikes and levees
			Paved	Gravel				
Haynie: He	Good		Fair to poor.	Good	Fair to poor.	Erodibility of slopes; moderate to high susceptibility to frost action; water table high in places; fill required in places; subject to overflow in places.	Poor bearing capacity; medium to high compressibility.	Erodibility of slopes; subject to piping in places.
Ida: IdC2, IdD, IdD2, IdE, IdE2.	Fair		Poor	Good	Fair to poor.	High erodibility of embankment slopes; high cuts and fills needed in places; high susceptibility to frost action.	Fair to poor bearing capacity.	
Judson: JuA, JuB	Good		Fair to poor.	Good	Fair to poor.	High susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	Erodibility of slopes; subject to piping in places.
Kennebec: Ke	Good		Fair to poor.	Good	Fair to poor.	Moderate to high susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	Erodibility of slopes; may crack when dry.
Lamo: 2La, Lb	Good		Fair to poor.	Good	Fair to poor.	High susceptibility to frost action; in places water table rises to surface; 4 to 7 feet of fill required in places; occasionally flooded.	Fair to poor bearing capacity; wet in places.	Moderate erodibility of slopes; may crack when dry.
Luton: Ls, Lk	Fair to poor.		Poor	Good	Fair to poor.	High susceptibility to frost action; high water table; 4 to 7 feet of fill required in places; plastic; erodibility on slopes; difficult to load and unload in places.	Fair to poor bearing capacity; poor shear strength; high compressibility.	Erodibility of slopes; plastic; cracks when dry.

interpretations—Continued

Soil properties affecting—Continued						Soil limitations for sewage disposal	
Low dams		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment						
Low to moderate seepage.	Fair stability; moderate erodibility; subject to piping in places.	Moderately well drained.	High available water capacity.	----------	Erodibility of subsoil.	Slight	Moderate: subject to piping; sealing required in places.
Moderate seepage.	Fair to poor stability; fair to good workability; foundation drains may be necessary; close control required.	Good internal drainage; runoff excessive.	High available water capacity; high erodibility of slopes.	Erodibility; steep and irregular slopes make alinement difficult.	High erodibility; maintenance costs high in places; steep slopes.	Moderate on slopes of less than 10 percent; severe on slopes of more than 10 percent.	Severe: slopes; moderate permeability.
Low to moderate seepage.	Fair to good stability; impervious.	Generally well drained.	High available water capacity; erodibility of slopes.	Moderate erodibility.	Moderate erodibility.	Slight	Moderate.
Moderate seepage.	Good to poor stability; impervious; good to poor workability; moderate to high compressibility.	Moderately well drained.	High available water capacity.	Erodibility of diversion slopes.	Moderate erodibility.	Moderate: subject to flooding.	Moderate: requires sealing in places.
Low seepage; may be suitable for dugouts.	Good to poor stability; fair to poor workability; foundation drains may be necessary; moderate to high compressibility.	Moderately slow surface and internal drainage; adequate outlets may not be available; high water table in places.	High available water capacity; adequate drainage necessary; slow intake rate.	----------	Seepage in wet areas in places; moderate erodibility.	Severe: water table at a depth of 2 to 10 feet; moderately slow permeability; subject to flooding.	Moderate: requires sealing in places.
Low seepage; generally suitable for excavated ponds.	Fair to poor stability; fair to poor workability; plastic.	Poor surface and internal drainage; occasionally flooded; high water table in places.	High available water capacity; adequate drainage necessary; slow intake rate.	----------	Clayey; poor workability; wet in places.	Severe: slow permeability; water table at a depth of 3 to 8 feet.	Slight.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil properties affecting—			
	Topsoil	Sand	Road subgrade		Road fill	Highway locations	Foundations	Dikes and levees
			Paved	Gravel				
McPaul: Mc	Good		Fair to poor.	Good	Fair to poor.	Moderate susceptibility to frost action; subject to flooding; fill required in places; slopes erodible.	Fair to poor bearing capacity.	Erodibility of slopes; subject to piping in places.
Monona: MnB, MnB2, MnC, MnC2, MnD, MnD2, MnF.	Good		Fair to poor.	Good	Fair to poor.	Erodibility of slopes; high susceptibility to frost action; steep and in places cuts and fills needed.	Fair to poor bearing capacity.	
Moody: MyC, Mo, MoB, MoB2, MoC, MoC2.	Good		Fair to poor.	Good	Fair to poor.	High susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	
Nora: NoB2, NoC, NoC2, NoD, NoD2, NoE2.	Fair to good.		Poor	Good	Fair to poor.	Moderate to high susceptibility to frost action; erodibility of slopes.	Fair to poor bearing capacity.	
*Onawa: Oc, ON (For properties of Haynie soil in mapping unit ON, refer to Haynie series in this table.)	Poor	Poor: thin layers of fine sand occur at a depth below 2 feet in places.	Poor to a depth of 20 inches, fair to poor below.	Good to fair in surface layer, fair to poor below.	Fair to poor.	High susceptibility to frost action; seasonal high water table; subject to ponding and occasional flooding; fill of 4 to 7 feet required; erodibility of slopes.	Fair to poor bearing capacity; wet in places.	Erodibility of slopes; slopes need protective cover in places.

interpretations—Continued

Soil properties affecting—Continued: Low dams: Reservoir area	Soil properties affecting—Continued: Low dams: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Soil limitations for sewage disposal: Waterways	Septic tank filter fields	Sewage lagoons
Moderate to high seepage.	Fair to good stability; close control required; foundation drains needed in places.	Generally good internal and surface drainage; subject to flooding.	High available water capacity; protection from flooding needed.	--------------	Erodibility; subject to flooding and silting.	Moderate: subject to flooding.	Severe: subject to flooding; moderately permeable.
Low to moderate seepage.	Fair to good stability; semi-impervious; erodibility of slopes; subject to piping.	Good internal and surface drainage.	High available water capacity; high erodibility of steep slopes.	Erodible; irregular relief causes problems in layout and construction in places.	High erodibility; maintenance costs may be high.	Slight on slopes of less than 5 percent; moderate to severe on slopes of more than 5 percent.	Moderate to severe: slopes and moderate permeability
Generally low seepage.	Good to poor stability; impervious; plastic; fair to poor workability; moderate compressibility.	Generally well drained.	High available water capacity; erodibility of slopes.	Erodibility; high maintenance costs of steep slopes.	Erodibility; maintenance costs may be high.	Severe: moderately slow permeability; slopes.	Slight on slopes of less than 2 percent; moderate on slopes of more than 2 percent.
Low to moderate seepage.	Fair to good stability; fair to good workability; impervious; may require toe drains.	Well drained----	High available water capacity; erodibility of slopes.	Irregular relief causes difficulty in layout and construction in places; maintenance costs may be high.	High erodibility; maintenance costs may be high.	Moderate on slopes of less than 10 percent. Severe: on slopes of more than 10 percent.	Moderate on slopes of less than 7 percent. Severe: on slopes of more than 7 percent.
High seepage---	Slopes erodible; fair to poor stability.	Seasonal high water table; surface ponding; occasional flooding; adequate outlets not available in places.	High available water capacity; slow intake rate; adequate drainage required.	Erodibility of diversion slopes.	Erodibility of subsoil; wet in places.	Severe: high water table; flooding.	Moderate: sealing and protection from flooding required in places.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of— Topsoil	Sand	Road subgrade: Paved	Road subgrade: Gravel	Road fill	Soil properties affecting— Highway locations	Foundations	Dikes and levees
Ortello: OrB, OrC2	Fair to good.	Fine: Fine sand below a depth of 3 feet.	Fair to good.	Poor	Good	Low susceptibility to frost action; subject to soil blowing in places; erodibility of slopes; slopes need protective cover in places; sand below a depth of 3 feet hinders hauling in places.	Good bearing capacity if sand is confined; subject to piping in places.	
Sarpy: Sb	Fair to poor.	Good: Fine sand below a depth of 1 foot.	Good	Poor	Fair to good.	Low susceptibility to frost action; susceptible to soil blowing; erodibility of slopes; minimum fill required in places.	Good bearing capacity if sand is confined; wet in places.	Erodibility of slopes; subject to piping.
Steinauer: StE	Fair; limited quantity.		Poor	Good	Fair to poor.	High susceptibility to frost action; erodibility of slopes; steep and high cuts and fills required in places.	Fair to poor bearing capacity; moderate to high shrink-swell potential.	
Thurman: TcB, TxE	Poor	Good: Fine sand below a depth of 2 feet.	Good	Poor	Good	Susceptibility to frost action low to none; erodibility of slopes by wind and water; loose sand hinders hauling in places.	Good to poor bearing capacity, depending on density; subject to severe piping (liquefaction) in places.	
Wet alluvial land: Wx	Fair to poor.		Poor	Good to fair.	Fair to poor.	High susceptibility to frost action; high water table; subject to occasional flooding; fill of 4 to 7 feet required in places; erodibility of slopes.	Fair to poor bearing capacity; wet in places.	Erodibility of slopes; cracks when dry.

interpretations—Continued

Soil properties affecting—Continued						Soil limitations for sewage disposal	
Low dams		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment						
High seepage	Fair to good stability; subject to piping; good workability; low compressibility.	Well drained	Moderate available water capacity; droughty in places; moderately rapid intake rate.	High erodibility; construction and maintenance costs may be high.	Erodibility; low fertility if sand is exposed; establishment and maintenance costs may be high.	Slight on slopes of less than 5 percent. Moderate on slopes of more than 5 percent.	Severe: rapid permeability; embankments subject to piping; requires sealing.
High seepage; suitable for excavated ponds in places.	Fair to good stability; erodibility of slopes; subject to piping; good workability.	Poor surface drainage in places; good internal drainage; high water table in places; adequate outlets not available in places.	Low available water capacity; adequate drainage required; rapid intake rate.	------------	Erodibility; poor fertility in places; establishment and maintenance costs may be high.	Moderate: subject to flooding.	Severe: rapid permeability; requires sealing.
Low seepage	Fair to good stability; erodibility of slopes; impervious; fair to poor workability.	Good internal drainage; runoff excessive.	Erodibility of slopes; high available water capacity.	High erodibility of slopes; construction and maintenance costs may be high.	High erodibility; difficult to vegetate; construction and maintenance costs may be high.	Severe: moderately slow permeability; slopes.	Severe: steep slopes.
High seepage	Erodibility of slopes; subject to piping; fair to good stability; generally good workability.	Well drained	Low available water capacity; rapid intake rate; subject to soil blowing.	Erodibility of diversion slopes by wind and water; irregular relief makes good alinement difficult; maintenance costs may be high.	Erodibility by wind and water; droughty; maintenance costs may be high.	Slight on slopes of less than 5 percent. Moderate on slopes of more than 5 percent.	Severe: rapid permeability; requires sealing.
Low to moderate seepage; can be used for excavated ponds.	Poor to good stability; impervious; fair to poor workability; moderate to high compressibility.	Poor internal and surface drainage; high water table and occasional flooding; adequate outlets not available in places.	Not suitable	------------	------------	------------	Severe: requires sealing and protection from flooding.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—					Soil properties affecting—		
	Topsoil	Sand	Road subgrade		Road fill	Highway locations	Foundations	Dikes and levees
			Paved	Gravel				
Zook: Zo, Zc	Poor to fair.		Poor	Good	Poor	High susceptibility to frost action; ponding of water on surface; 4 to 7 feet of fill required in places.	Fair to poor bearing capacity; high compressibility; wet in places.	Erodibility of slopes; cracks when dry.

rated for this use. The ratings apply only to the upper 18 inches of the soil. If large dikes or levees are planned, a detailed investigation of the site is needed.

Water generally is held satisfactorily above small earth dams in this county without sealing protection. Seepage losses generally are low.

In compacted embankments, the soils of the county generally have fair to good stability. Except for the more plastic clays, workability generally is fair to good. Toe drains may be required for embankments built on these soils.

Some of the soils have poor natural drainage because of a seasonally high water table, slow permeability, or both. Many of these soils also are subject to flooding, and others are nearly level and have slow runoff. Permeability, relief, height of the water table, and availability of outlets determine the kind of drainage that can be used effectively. These features are named for the soils to which they apply in table 6.

The main soil properties that affect irrigation are available water capacity and the intake rate of water. In table 6 the interpretations for available water capacity in the irrigation column are to a depth of 5 feet. The available water capacity is *high* if the soil holds more than 9 inches of water to that depth; *moderate*, if the soil holds 6 to 9 inches; *low*, if the soil holds 3 to 6 inches; and *very low*, if the soil holds less than 3 inches. The intake of water is rated only if the rate is rapid or slow. The intake rate is that amount of water that enters the soil, under sprinkler or border irrigation, when the soil has a cover of alfalfa or grass. The rate is expressed in inches per hour. A *slow* intake rate is less than ½ inch per hour, and a *rapid* one is 2 inches or more per hour.

Irrigation hazards related to slope are not listed for all soils in table 6. The Nebraska Guide for Central and Eastern Nebraska (7) contains information on the suitability of the soils for irrigation.

Because the soils in much of the acreage in crops are susceptible to erosion, field terraces are commonly used in this county for conserving soil and water. Diversion terraces are used extensively below terraces or below fields in grass to protect lower lying, more nearly level soils from runoff. The slopes of terraces generally are erodible, but the cost of maintenance generally is not extremely high. Exceptions are terraces built on the steep soils.

Waterways are commonly used in the county. The ratings are based on construction hazards as well as on the hazard of erosion after construction but before vegetation is established. The semihumid climate helps in establishing vegetation.

The degree and kinds of limitations for sewage disposal systems are shown in table 6. Residences outside the areas served by public sewer systems normally use a septic tank subfilter field, and developers of small housing areas may prefer to use a sewage lagoon. Therefore, the suitability of the soils for both methods of sewage disposal are shown in table 6. The limitations are rated *slight*, *moderate*, and *severe*. If rated as *moderate* or *severe*, the limiting features are shown. It should be pointed out that the ability of a soil to transmit water during a short period is not necessarily a measure of its ability to absorb sewage over a long period. Before installing a septic tank and filter field, percolation tests should be made at the site and a study made of any existing installations on similar soils. Also consideration should be given to the proximity of wells and possible contamination of them.

Formation and Classification of Soils

In this section the factors that have affected the formation of the soils in Thurston County are discussed. Then the current system of soil classification is explained and the soil series are placed in higher categories. The soil series in the county, including a profile representative of each series, are described in the section "Descriptions of the Soils."

Soil-Forming Factors

Soil is formed by the physical and chemical weathering of parent materials. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the parent material has accumulated and existed since accumulation; (3) the plants and animals on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

interpretations—Continued

Soil properties affecting—Continued						Soil limitations for sewage disposal	
Low dams		Agricultural drainage	Irrigation	Terraces and diversions	Waterways	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment						
Low seepage; can be used for excavated ponds.	Fair to poor stability; fair to poor workability; impervious; moderate to high compressibility.	Poor internal and surface drainage; occasional flooding; adequate outlets not available in places.	High available water capacity; slow intake rate; adequate drainage required.	--------------	Clayey; poor workability; wet in places.	Severe: slow permeability; subject to flooding.	Slight: protection from flooding needed in places.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material.—Parent material is the unconsolidated mass from which a soil forms. It determines the chemical and mineralogical composition of the soil. In Thurston County the soils formed in four kinds of parent material: Peoria loess, alluvium, glacial till, and sand (*3*).

The soils that formed in loess are the most extensive. The loess is friable, yellowish-brown to light brownish-gray, calcareous, silty material that probably averages about 40 feet in thickness but may range up to nearly 100 feet in thickness. The material was first laid down by water along large rivers and streams and then carried into the uplands by wind. The silt is coarser and the percentage of sand is greater in the loess in the bluff zone near the Missouri River.

Soils that formed in Peoria loess are the Monona and Ida in the eastern part of the county and the Belfore, Moody, Nora, and Crofton in other parts of the county. These soils are friable to very friable. Depth to the calcareous silty loess varies.

Alluvium is the parent material of soils on bottom lands of streams throughout the county. It ranges from clay to sand in texture. Some of the deposits originated within the county and were deposited along streams throughout the uplands. Other deposits originated outside the county and were deposited by floods along the Missouri River. The deposits along the Missouri River are fairly recent, and many were laid down as late as 1952 before most of the dams were built upstream to provide flood control. The largest area of alluvium is in Logan Valley, and here such soils as the Colo, Kennebec, Lamo, Luton, and Zook have formed. Along upland drainageways are large areas of Colo, Judson, Lamo, and McPaul soils, and along the Missouri River are soils of the Albaton, Haynie, Sarpy, and Onawa series.

Glacial till, the parent material for some of the soils on uplands, is exposed below the loess on many of the side slopes. It generally is calcareous, and in many places it contains large aggregates of free lime. Both the Burchard and Steinauer soils formed in glacial till, but they differ in thickness and in degree of development.

Soils formed in wind-laid sandy deposits occur in some areas. The sandy material covers loess areas in places in the western part of the county on uplands adjoining the Logan Valley. It ranges from a few feet to about 10 or more feet in depth. The Thurman and Ortello soils formed in deep deposits of sandy material, and the Moody fine sandy loams formed in sandy material deposited over loess.

Greenhorn limestone, Graneros shale, and Dakota sandstone are exposed in the northeastern part of the county (fig. 19). The exposures are small and are shown on the detailed soil map by the standard symbol for rock outcrop.

Climate.—The climate of Thurston County is midcontinental and subhumid. Rainfall is fairly light, and humidity is low; summers are hot, and winters are severe. Temperature and rainfall vary widely from year to year, and frequent changes in weather occur from day to day and from week to week. The climate is fairly uniform throughout the county, and differences among the soils are not the result of differences in climate.

In Thurston County leaching is not so great as it is in similar soils where rainfall is higher. Soils in this county therefore are less acid, even though well drained, than similar soils in a more humid climate that formed from similar parent material and have similar relief. They also are less weathered. In the gently sloping to steep, highly calcareous Crofton and Ida soils, for example, little leaching has occurred. As a result free calcium tends to keep the colloidal clay granulated, and there is little downward movement of clay in the soil profile.

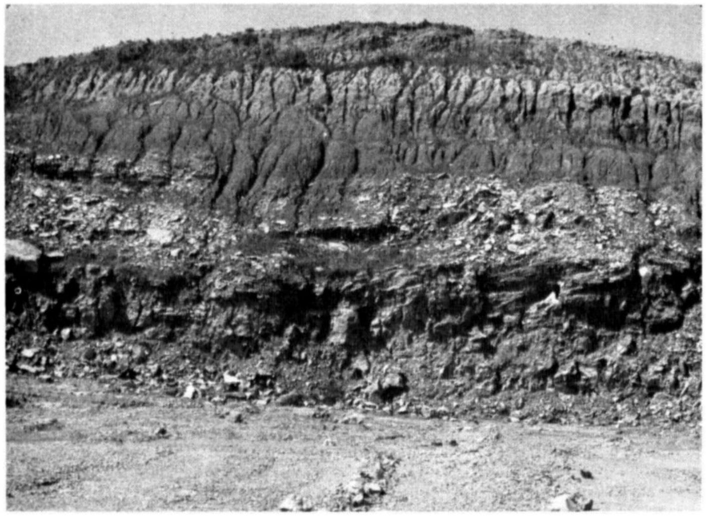

***Figure 19.*—Graneros shale and Greenhorn limestone capped with glacial till and Peoria loess.**

Precipitation is sufficient on the level to sloping areas of the county to leach the soils to varying degrees and for horizons to develop. On steeper slopes and on slopes that are exposed more directly to wind, runoff and evaporation are greater and less leaching generally occurs. Erosion caused by rain and wind also is a factor in development of the soils, especially on the steep, more exposed slopes. In addition alternate freezing and thawing tend to flocculate the soils into aggregates.

Plants and animals.—Plants, animals, micro-organisms, earthworms, and other organisms are active in soil-forming processes. The kinds of plants and animals that live in and on the soil are affected, in turn, by the climate, the parent material, relief, and age of the soil.

The original vegetation in the county was mainly grasses, though trees grew along the streams. Grasses therefore have been more important than trees in the formation of the soils. Each year the grasses developed new growth above ground and their fibrous root system grew in the upper few feet of the soil. In time an upper layer moderately high in organic matter formed in the soils. Deep-rooted grasses bring water from deeper horizons along with calcium and other soluble bases and some iron and alumina. They also bring many more elements in smaller amounts to the surface through their stems and leaves. This process of redistribution tends to keep the soils productive, and the plants growing. The decay of the organic materials forms various organic acids that in solution hasten the leaching processes of soils.

Earthworms and small burrowing animals aid in mixing the soil material by bringing deeper material to the surface. In this way they also help to keep the soils supplied with minerals.

Relief.—Through its effect upon drainage, aeration, and erosion, relief is an important factor in the formation of soils. Many soil differences in Thurston County are the results of differences in relief.

In general, runoff is more rapid and the content of moisture is less in steep soils than in more nearly level soils. Differences among soils caused partly by differences in relief can be observed in the Ida and Monona soils on loess, and the Steinauer and Burchard soils on till. Much of the rainfall runs off the Ida and Steinauer soils. As a result little water enters the soils, growth of plants is poor, and soil formation proceeds slowly even if the soil material is rich in weatherable minerals. Soil horizons are thin and indistinct. Unless a good cover of vegetation is maintained, erosion may remove soil material faster than horizons can form. The Monona and Burchard soils have more moderate slopes. Runoff therefore is less and the soils are better developed and have a deeper profile.

Soils in nearly level areas are likely to be wet because of slow runoff or a high water table. In these poorly drained areas decay of organic materials is slow or incomplete. At times capillary action from the water table dissolves salts and deposits them at or near the surface and makes the soils alkali. In level areas along streams, runoff from higher lying areas and from flooding is slowed and sediment is laid down. In such material many of the alluvial soils have formed.

Time.—Time is required for soils to form from parent material. If the parent material has been in place or exposed for only a short time, climate and plants and animals have not had time to act on the soil material to change it into a soil. On steep slopes the soil material is constantly being removed and new material exposed to weathering, and on many bottom lands fresh deposits of material are laid down by floodwater. Soils in all of these areas have not had time to develop differentiating horizons and are considered young. Examples of soils developing in recently deposited sediment are the McPaul and Haynie. They are forming in sediment deposited within the last century and within the last few years.

The degree of profile development depends on the intensity of the different soil-forming factors, on the length of time they have been active, and the nature of the materials from which the soils were derived. Differences in the length of time that geologic materials have been in place, therefore, are commonly reflected in the distinctness of horizons in the soil profile.

Soils that have been in place for a long time and have approached equilibrium with their environment are considered mature, or old. Belfore and Moody soils are examples of soils that have been in place long enough for distinct horizons to develop.

Soil-Forming Processes

Several processes take place in the formation of soil horizons. The main processes are the accumulation of organic matter, the leaching of calcium carbonates and bases, the reduction and transfer of iron, and the formation and translocation of silicate clay minerals. In most soils in the county, two or more of these processes have been active in the formation of horizons.

The accumulation of organic matter in the upper part of the profile to form an A1 horizon has been important. The soils of the county range from high to very low in content of organic matter, depending in part on the degree of erosion.

Leaching of carbonates and bases has occurred in some of the soils. Generally the leaching of bases in soils precedes translocation of silicate clay minerals. This leaching has contributed to the formation of horizons, for most soils in the county are slightly to moderately leached.

Reduction and transfer of iron, a process called gleying, is evident in the poorly and very poorly drained soils. This reduction and transfer is indicated by grayish colors in the subsoil. The reddish-brown mottles and concretions in some horizons indicate the segregation of iron.

The translocation of clay minerals has contributed to the formation of horizons in some of the soils. In such soils the B horizon generally has an accumulation of clay (clay films) in pores and on peds.

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be used in managing farms, fields, and woodland; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and later revised (*5*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. It is under continual study (*4*, *8*). Therefore, readers interested in developments of the current system should search the latest literature available. The soil series of Thurston County are placed in some categories of the current system in table 7.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a bases for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar origin are grouped together. The classes of the current system are briefly defined in the following paragraphs.

ORDERS. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, the Entisols and Histosols, occur in many different kinds of climate. The two orders in Thurston County are Entisols and Mollisols. *Entisols* are recent mineral soils that do not have natural genetic horizons or that have only the beginnings of such horizons. *Mollisols* formed under grass. They have a soft, dark-colored surface layer and are high in bases.

SUBORDERS. Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation.

GREAT GROUPS. Soil suborders are separated into great groups on basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium) and the like. The great group is not shown separately in table 7, because it is the last word in the name of the subgroup.

TABLE 7.—*Soil series classified according to the current system of classification* [1]

Series	Family	Subgroup	Order
Albaton	Fine, montmorillonitic, calcareous, mesic	Vertic Haplaquents	Entisols.
Belfore	Fine, montmorillonitic, mesic	Udic Argiustolls	Mollisols.
Burchard	Fine-loamy, mixed, mesic	Udic Argiustolls	Mollisols.
Colo	Fine-silty, mixed, noncalcareous, mesic	Cumulic Haplaquolls	Mollisols.
Crofton	Fine-silty, mixed, calcareous, mesic	Typic Ustorthents	Entisols.
Haynie	Coarse-silty, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Ida	Fine-silty, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Lamo	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Luton	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
McPaul	Coarse-silty, mixed, calcareous, mesic	Typic Udifluvents	Entisols.
Monona	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Moody	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Nora	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Onawa	Clayey over loamy, montmorillonitic, calcareous, mesic	Mollic Haplaquents	Entisols.
Ortello	Coarse-loamy, mixed, mesic	Udic Haplustolls	Mollisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Steinauer	Fine-loamy, mixed, calcareous, mesic	Typic Udorthents	Entisols.
Thurman	Sandy, mixed, mesic	Udorthentic Haplustolls	Mollisols.
Zook	Fine, montmorillonitic, noncalcareous, mesic	Cumulic Haplaquolls	Mollisols.

[1] Classification as of March 1970. Placement of some soil series in the current system of classification, particularly in families, may change as more information becomes available.

SUBGROUPS. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Ustorthents.

FAMILIES. Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. An example is the fine-silty, mixed, calcareous, mesic family of Typic Ustorthents.

Laboratory Data

Samples of Crofton, Nora, and Moody soils have been analyzed in Soil Survey laboratories. The data have been published in "Soil Survey Investigations Report No. 5" (*9*). The samples were obtained from locations outside Thurston County, but the data are considered characteristic of these soils as they occur in Thurston County. The data are useful to soil scientists in classifying soils and in developing concepts of how the soils form. They are also helpful in estimating available water capacity, fertility, tilth, and other properties that affect soil management.

General Nature of the County

Thurston County was organized in 1889. It originally was part of the acreage selected in 1855 by the Omaha Indians, who in 1865 sold part of their reservation to the Winnebago Indians. All of the land west of the Chicago, St. Paul, Minneapolis, and Omaha Railroad that crossed the county was opened to settlement in 1884. The first settlement was made that year along Logan Creek near the present site of Pender.

Pender was established as the county seat in 1886. Other towns in the county are Macy, Rosalie, Thurston, Walthill, Winnebago, and part of Emerson. Schools and churches are accessible to all residents, and two hospitals are in the county. According to data compiled by the Winnebago Agency, Bureau of Indian Affairs, the Omaha Indian Reservation, in the southeastern part of the county, consists of about 26,910 acres and has 1,367 residents. These data also show that the Winnebago Indian Reservation, in the northern part of the county, consists of about 29,967 acres and has 782 residents. According to the U.S. Census, a total of 7,059 persons were living in the county in 1970.

Transportation is available to all parts of the county. A major railroad extends north and south across the eastern part of the county, and another crosses the northwestern part. Federal and State highways connect the main communities. In addition State and county highways have been built in all parts of the county. Roads are on most section lines, though in the northeastern and eastern parts of the county roads follow contours, are along drainageways, or are along ridgetops. Most of the roads are graded and are kept in good condition. Several buslines also are in the county. In addition motor freight lines and railroads provide facilities for shipping crops and livestock to market.

Transportation also is provided by a major airline at Sioux City about 40 miles northeast of Pender. The airport at Pender provides facilities for small aircraft only. Barge transportation on the Missouri River in spring, summer, and fall connects the county to water ports outside the county.

The fertile soil and adequate supply of water make farming the most important enterprise in the county. Some commercial fishing is done, however, in the Missouri River. Lime is quarried for farm use near Winnebago, and gravel and sand for use in construction are obtained from glacial deposits in the eastern third of the county. Opportunities for development of recreational areas are available in the eastern part of the county. The topography is favorable, and the area is close to large centers of population in Omaha and in Sioux City.

Physiography, Relief, and Drainage

Thurston County is in two distinct topographic areas. These are the uplands that have a mantle of loess and the bottom lands along the Missouri River and other large streams. The uplands are part of the dissected plain that makes up the eastern part of Nebraska. They are gently rolling to moderately rolling in the western part of the county and rolling and strongly rolling in the eastern part. Near the Missouri River the hills are steeper, and the area is more deeply dissected. Slopes generally do not exceed 10 percent in the western part of the county, but they range from 10 to 30 percent in the eastern part.

Sandstone and shale of the Dakota group (Lower Cretaceous) underlie parts of the county. Over the bedrock is glacial till of Kansan and Nebraskan ages. The upper part of the till, which is the Kansan, is exposed along the most deeply entrenched streams. Brown to brownish-red silty to clayey material of the Loveland Loess covers the surface of the till. This material ranges from 1 foot to several feet in thickness. The Peoria Loess that covers all of the uplands averages about 40 feet in thickness. The deposits of loess generally are thickest on the south and east sides of the ridges.

The bottom lands in the county are as much as 400 feet below adjacent uplands. The deepest cut is about 400 feet along the Missouri River, but dissections are less farther west. In the Logan Creek drainage system, the cuts range from 150 to 200 feet. Elevation at the city of Pender is 1,347 feet.

Thurston County is drained mainly by the Missouri River and Logan and Omaha Creeks. Drainage generally is to the southeast, but the lower end of Omaha Creek flows due north.

In the past frequent flooding along the Missouri River restricted farming on the bottom lands. Dams built upstream and stabilization work done along the river have reduced flooding. As a result, areas formerly used for grazing or as woodland now produce cultivated crops. In the Logan Creek valley, dredging has made the stream channel deep and wide. The creek now carries away nearly

all of the water from heavy rains and spring thaws, and flooding seldom occurs. Formerly this valley was frequently flooded, and the soils were wet. These soils now are moderately well drained to well drained. All other drainageways in the county have some flooding problems. Also, washing causes heavy silting where conservation practices have not been applied on excessively eroded, rolling, silty soils on the uplands.

Ground Water [7]

Water for domestic purposes and for watering most of the livestock in the county comes from wells. Farm ponds and streams supplement the supply of water for livestock. In many of the wells in the western two-thirds of the county, water is obtained from sand and gravel in or at the base of glacial clay. This water is hard, but it generally is adequate and of acceptable quality. Water in deeper wells in the eastern third of the county is from sand and gravel associated with glacial clay or from sandstone of the Dakota formation. In places the water from the Dakota sandstone has a higher mineral content than that of the glacial sand and gravel. It is acceptable for domestic and livestock uses, but in some areas dissolved sulfates and chlorides give the water an unpleasant taste.

An adequate supply of good water for domestic and livestock uses generally can be obtained from alluvium in valleys of streams. Wells in these valleys and wells on terraces generally are less than 50 feet deep. Water perched above glacial clay or in the clay and associated deposits can be trapped and used throughout the county. Most existing perched wells are less than 100 feet deep, and they are dug, augered, or drilled. The supply from these sources frequently is inadequate during long dry periods.

Ground water is available in sufficient quantity and quality in some parts of the county to develop irrigation wells. As of January 1, 1969, 18 irrigation wells had been registered with the State Department of Water Resources. The wells are mainly in the western part of the county, mostly along Logan Creek.

Most of the water for irrigation is found in the Logan Creek valley and adjoining areas and in the Missouri River valley. Here the quantity and quality of the water generally are more favorable than in other parts of the county. Also, the depth of the wells and the pumping lifts do not cause excessive expense, and recharge generally is more favorable. Water-saturated sand and gravel of sufficient thickness for irrigation wells also is present in places in restricted channels in the central part of the county. Test drilling is necessary, however, and holes should be drilled down as far as the bedrock. The potential for irrigation wells in the uplands in the eastern part of the county is quite limited.

In places in the county, test holes have been drilled as a part of the statewide ground water survey made by the Conservation and Survey Division, University of Nebraska, and the Ground Water Branch, U.S. Geological Survey. When test drilling is completed, more information about the ground water supply of Thurston County will be available.

[7] By V. H. Dreeszen, Conservation and Survey Division, University of Nebraska.

Climate [8]

Thurston County is in the northeastern part of Nebraska near the center of the United States. The climate is distinctly continental. Summers are relatively warm, winters are cold, and rainfall is moderate. The temperature and rainfall vary greatly, however, from day to day and from season to season. The Missouri River along the eastern border of the county has little influence on the weather. Most of the rain that falls in the county is the result of southerly winds that bring moist air from the Gulf of Mexico. The rapid changes in temperature are caused by an interchange of warm air from the south and southwest and of cold air from the north and northwest. Temperature and precipitation data for the county are given in table 8.

More than three-fourths of the annual precipitation generally falls during the period of April to September. This period covers the major part of the active growing season. Precipitation early in spring is slow and steady, and it is well distributed. As the season advances, more and more of the rain falls during erratic thundershowers. By the latter part of May all precipitation comes in such showers. Thunderstorms in spring and early in summer are severe at times, and some of them are accompanied by heavy local downpours, hail, and damaging winds. Occasionally a tornado occurs. Heavy rains are likely to fall in one area, and an adjacent area will receive little or no rain. Locally drought develops when the time or distribution of showers is poor.

An inch of rain falls in half an hour on an average of once a year, and more than 2 inches falls in 2 hours about once in 5 years. Rain falls in even greater intensity for brief periods. About once every 2 years a local downpour of 4 inches per hour will last 5 to 10 minutes. These heavy rains cause serious erosion problems on steep slopes. Hailstorms that accompany some of the heavy downpours generally are local and last only a short time. Damage from hail is variable and occurs in scattered areas.

Fall weather is characterized by an abundance of sunshine, mild days, and cool nights. Precipitation in winter generally comes as light snow. Strong northerly winds and low temperatures frequently accompany the snow. The average annual snowfall is about 32 inches, but the amount of snow varies considerably from year to year. The snow frequently melts between falls. Snow covers the ground for 54 days in an average winter.

In a fifth of the years (table 8) at least 4 days in July can be expected to have a temperature of 98° F. On the other hand, in a fifth of the Januarys the temperature falls to 14° below zero or lower on four nights. The temperature in the county has been as high as 113° in 1936 and as low as 45° below zero in 1912.

The growing season, which is the number of days between the last freezing temperature in spring and the first in fall, averages about 147 days. The probabilities of freezing temperatures are shown in table 9. This table shows that the average date of the last 32° temperature is May 6, and the average date of the first one in fall is October 1. A hard freeze of 16° can be expected before October 20 in 1 year in 10.

[8] By Richard E. Myers, State climatologist, National Weather Service, U.S. Department of Commerce.

TABLE 8.—*Temperature and precipitation*

[All data at Walthill; probabilities of precipitation based on period 1900–66; all other data based on period 1937–66]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with—		Average monthly total	One year in 10 will have—		Days with 1 inch or more snow cover	Average depth of snow on days with snow cover
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Equal to or less than—	Equal to or more than—		
	°F.	°F.	°F.	°F.	Inches	Inches	Inches	Number	Inches
January	30	8	49	−14	0.7	0.2	1.4	16	4
February	35	13	53	−10	1.0	.1	1.8	15	5
March	44	23	72	4	1.5	.5	2.3	9	6
April	62	36	81	22	2.3	.7	4.1	1	3
May	74	48	89	34	3.7	1.4	7.2	(1)	4
June	82	58	97	45	4.8	2.2	7.6		
July	88	63	98	52	3.5	1.2	6.4		
August	86	61	98	48	3.2	1.3	5.7		
September	77	50	93	35	2.6	.4	5.9		
October	68	39	85	23	1.4	.3	3.3	(1)	3
November	49	25	68	8	.9	(2)	3.0	3	3
December	36	15	55	−6	.6	.1	1.6	10	3
Year	61	37	[3]101	[4]−20	26.2	17.2	34.7	54	4

[1] Less than 0.5 day.
[2] Trace.
[3] Average annual highest maximum.
[4] Average annual lowest minimum.

Annual evaporation of free water from shallow lakes in the county averages about 39 inches. About 77 percent of the total evaporation occurs between May 1 and October 31.

Farming

Thurston County was first used as farmland in 1884. Prior to that time most of the county was covered by medium and tall prairie grasses. Dense wooded areas were along the larger streams and on bluffs along the Missouri River. A few small areas were cultivated by the Indians for subsistence. In 1902 the Congress passed a law that permitted heirs of deceased Indians to sell their allotted land, and Indian land in Thurston County was made available to the public. Settlers, most of them farmers, came into the area, and today about 76 percent of the land is owned by persons who are not Indian.

Farming in the county consists mainly of growing grain for feeding livestock for production of beef and pork. Many of the feeder cattle are raised outside the county, but the pigs are raised locally. Corn, soybeans, oats, and sorghum occupy the largest acreages. Sweetclover, alfalfa, and tame grass are used for forage and as soil-building crops. Soybeans are mainly a cash crop.

In 1964, according to the U.S. Census of Agriculture, 756 farms were in the county, and the average size of the farms was about 288 acres. Although the number of farms is decreasing, their size is increasing because of increased use of machines.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data at Walthill]

Probability	Dates for given probability and temperature				
	16° F.	20° F.	24° F.	28° F.	32° F.
Spring:					
1 year in 10 later than	April 12	April 19	April 30	May 12	May 22
2 years in 10 later than	April 6	April 13	April 25	May 7	May 16
5 years in 10 later than	March 27	April 3	April 14	April 26	May 6
Fall:					
1 year in 10 earlier than	October 20	October 16	October 6	September 23	September 10
2 years in 10 earlier than	October 26	October 21	October 12	September 29	September 21
5 years in 10 earlier than	November 6	October 31	October 22	October 9	October 1

According to the Nebraska Agricultural Statistics for 1967–68, 2,300 acres of land in Thurston County is irrigated. Most irrigation systems are used to supplement rainfall in years that are drier than normal. Consequently, some of the systems get only limited use. Most level and gently sloping soils in the county on the bottom lands and the uplands are suited to irrigation. Sufficient ground water for irrigation, however, is available chiefly in the Logan Creek and Missouri River valleys. Gravity and sprinkler systems are commonly used to apply irrigation water.

At the time of the 1964 Census of Agriculture, 248,320 acres, or nearly 88 percent of the land area was farmland. Of the land in farms, according to the 1967 Nebraska Conservation Needs Inventory, there were 197,690 acres of cropland; 17,400 acres of pasture and range; 19,300 acres of woodland; and 13,930 acres of miscellaneous land.

The Nebraska Agricultural Statistics Annual Report for 1967 shows that on the farms of Thurston County there were 51,500 cattle; 51,190 hogs; 6,500 sheep; and 83,850 chickens. This report also shows the following acreage of crops:

Corn	78, 590
Soybeans	27, 630
Oats	20, 780
Alfalfa	12, 500
Sorghum	6, 680

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bottom land. The normal flood plain of a stream, part of which may be flooded infrequently.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Horizon, soil. A layer of soil, approximately paralled to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and in Podzolic soils commonly have mottlings below 6 to 16 inches in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Parent material. The unconsolidated material from which the soil develops; the C horizon.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to descripe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5.	Neutral	6.6 to 7.3.
Very strongly acid	4.5 to 5.0.	Mildly alkaline	7.4 to 7.8.
Strongly acid	5.1 to 5.5.	Moderately alkaline	7.9 to 8.4.
Medium acid	5.6 to 6.0.	Strongly alkaline	8.5 to 9.0.
Slightly acid	6.1 to 6.5.	Very strongly alkaline.	9.1 and higher.

Runoff. The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing, proportion of fine particles, are *sand, loamy sand, sandy laom, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. In referring to a capability unit, a range site, or a windbreak suitability group, read the introduction to the section it is in for general information about its management. Absence of data in range-site column indicates soil was not placed in a range site. For facts about wildlife and recreation, turn to the section beginning on p. 38. Other information is given in tables as follows:

Acreage and extent, table 1, p. 8.
Predicted yields, table 2, p. 34.
Engineering uses of the soils, tables 4, 5, and 6, pages 42 through 57.

The State and county boundaries shown on the maps in this publication are approximate along the Missouri River and along the borders where the county lines are not on the roads. The boundary shown between Nebraska and Iowa was plotted from a base map compiled by the U.S. Corps of Engineers, dated January 30, 1940. This boundary was established as the State line by the Iowa-Nebraska Boundary Compact of 1943.

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Name	Page	Name	Page
Ak	Albaton silty clay-------------------------	9	IIIw-1	30	Clayey Overflow	36	Moderately Wet	38
Am	Albaton silty clay loam---------------------	9	IIIw-2	31	Clayey Overflow	36	Moderately Wet	38
BdD2	Burchard clay loam, 11 to 17 percent slopes, eroded---------------------------	10	IVe-8	31	Silty	36	Silty to Clayey	38
BLg	Rough broken land--------------------------	24	VIIe-1	32	--------------	--	Undesirable	38
BM	Belfore-Moody silty clay loams, 0 to 1 percent slopes---------------------------	9	I-1	28	Silty	36	Silty to Clayey	38
BnC	Burchard silt loam, 5 to 11 percent slopes--	10	IIIe-1	29	Silty	36	Silty to Clayey	38
BnD	Burchard silt loam, 11 to 17 percent slopes-	10	IVe-1	31	Silty	36	Silty to Clayey	38
CfB2	Crofton silt loam, 1 to 7 percent slopes, eroded-----------------------------------	12	IIIe-8	30	Limy Upland	36	Silty to Clayey	38
CfC2	Crofton silt loam, 7 to 11 percent slopes, eroded-----------------------------------	12	IVe-8	31	Limy Upland	36	Silty to Clayey	38
CfD2	Crofton silt loam, 11 to 17 percent slopes, eroded-----------------------------------	12	IVe-8	31	Limy Upland	36	Silty to Clayey	38
CfE2	Crofton silt loam, 17 to 31 percent slopes, eroded-----------------------------------	12	VIe-8	32	Limy Upland	36	Silty to Clayey	38
Ct	Colo silty clay loam-----------------------	11	IIw-4	29	Subirrigated	35	Moderately Wet	38
GL	Gullied land-------------------------------	12	VIIIe-1	32	-------------	--	Undesirable	38
He	Haynie silt loam---------------------------	13	I-1	28	Silty Lowland	36	Silty to Clayey	38
IdC2	Ida silt loam, 7 to 11 percent slopes, eroded------------------------------------	14	IVe-8	31	Limy Upland	36	Silty to Clayey	38
IdD	Ida silt loam, 11 to 17 percent slopes------	14	IVe-9	32	Limy Upland	36	Silty to Clayey	38
IdD2	Ida silt loam, 11 to 17 percent slopes, eroded-----------------------------------	14	IVe-8	31	Limy Upland	36	Silty to Clayey	38
IdE	Ida silt loam, 17 to 31 percent slopes------	14	VIe-9	32	Limy Upland	36	Silty to Clayey	38
IdE2	Ida silt loam, 17 to 31 percent slopes, eroded-----------------------------------	14	VIe-8	32	Limy Upland	36	Silty to Clayey	38
JuA	Judson silt loam, 0 to 2 percent slopes-----	15	I-1	28	Silty Lowland	36	Silty to Clayey	38
JuB	Judson silt loam, 2 to 7 percent slopes-----	15	IIe-1	28	Silty	36	Silty to Clayey	38
Ke	Kennebec silt loam-------------------------	16	I-1	28	Silty Lowland	36	Silty to Clayey	38
2La	Lamo silt loam, overwash-------------------	16	IIw-3	29	Silty Overflow	36	Moderately Wet	38
Lb	Lamo silty clay loam-----------------------	16	IIw-4	29	Subirrigated	35	Moderately Wet	38
Lk	Luton silty clay---------------------------	17	IIIw-1	30	Clayey Overflow	36	Moderately Wet	38
Ls	Luton silty clay loam----------------------	17	IIIw-2	31	Clayey Overflow	36	Moderately Wet	38
M	Marsh--------------------------------------	17	VIIIw-1	33	--------------	--	Undesirable	38
Mc	McPaul silt loam---------------------------	18	IIw-3	29	Silty Overflow	36	Moderately Wet	38
MnB	Monona silt loam, 1 to 7 percent slopes-----	19	IIe-1	28	Silty	36	Silty to Clayey	38
MnB2	Monona silt loam, 1 to 7 percent slopes, eroded-----------------------------------	19	IIIe-8	30	Silty	36	Silty to Clayey	38
MnC	Monona silt loam, 7 to 11 percent slopes----	19	IIIe-1	29	Silty	36	Silty to Clayey	38
MnC2	Monona silt loam, 7 to 11 percent slopes, eroded-----------------------------------	19	IIIe-8	30	Silty	36	Silty to Clayey	38
MnD	Monona silt loam, 11 to 17 percent slopes---	19	IVe-1	31	Silty	36	Silty to Clayey	38
MnD2	Monona silt loam, 11 to 17 percent slopes, eroded-----------------------------------	20	IVe-8	31	Silty	36	Silty to Clayey	38
MnF	Monona silt loam, 17 to 31 percent slopes---	20	VIe-1	32	Silty	36	Silty to Clayey	38
Mo	Moody silty clay loam, 0 to 1 percent slopes-----------------------------------	20	I-1	28	Silty	36	Silty to Clayey	38
MoB	Moody silty clay loam, 1 to 7 percent slopes-----------------------------------	21	IIe-1	28	Silty	36	Silty to Clayey	38

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak suitability group	
			Symbol	Page	Name	Page	Name	Page
MoB2	Moody silty clay loam, 1 to 7 percent slopes, eroded	21	IIIe-8	30	Silty	36	Silty to Clayey	38
MoC	Moody silty clay loam, 7 to 11 percent slopes	21	IIIe-1	29	Silty	36	Silty to Clayey	38
MoC2	Moody silty clay loam, 7 to 11 percent slopes, eroded	21	IIIe-8	30	Silty	36	Silty to Clayey	38
MyC	Moody fine sandy loam, 7 to 11 percent slopes	21	IIIe-3	29	Sandy	36	Sandy	38
NoB2	Nora silt loam, 1 to 7 percent slopes, eroded	22	IIIe-8	30	Limy Upland	36	Silty to Clayey	38
NoC	Nora silt loam, 7 to 11 percent slopes	22	IIIe-1	29	Silty	36	Silty to Clayey	38
NoC2	Nora silt loam, 7 to 11 percent slopes, eroded	22	IIIe-8	30	Limy Upland	36	Silty to Clayey	38
NoD	Nora silt loam, 11 to 17 percent slopes	22	IVe-1	31	Silty	36	Silty to Clayey	38
NoD2	Nora silt loam, 11 to 17 percent slopes, eroded	22	IVe-8	31	Limy Upland	36	Silty to Clayey	38
NoE2	Nora silt loam, 17 to 31 percent slopes, eroded	23	VIe-8	32	Limy Upland	36	Silty to Clayey	38
Oc	Onawa silty clay	23	IIIw-1	30	Clayey Overflow	36	Moderately Wet	38
ON	Onawa and Haynie soils	23	IIw-4	29	Clayey Overflow	36	Moderately Wet	38
OrB	Ortello fine sandy loam, 2 to 5 percent slopes	24	IIIe-3	29	Sandy	36	Sandy	38
OrC2	Ortello fine sandy loam, 5 to 11 percent slopes, eroded	24	IVe-3	31	Sandy	36	Sandy	38 38
Rw	Riverwash	24	VIIIs-1	33	---------------	--	Undesirable	38
Sb	Sarpy soils	25	IIIe-5	30	Sandy Lowland	36	Sandy	38
StE	Steinauer soils, 11 to 30 percent slopes	25	VIe-9	32	Limy Upland	36	Silty to Clayey	38
Sy	Silty alluvial land	25	VIw-1	32	Silty Overflow	36	Wet	38
TcB	Thurman loamy sand, 1 to 7 percent slopes	26	IIIe-5	30	Sandy	36	Sandy	38
TxE	Thurman soils, 7 to 17 percent slopes	26	VIe-5	32	Sands	36	Sandy	38
Wx	Wet alluvial land	26	Vw-1	32	Wet Land	35	Wet	38
Zc	Zook silty clay	27	IIIw-1	30	Clayey Overflow	36	Moderately Wet	38
Zo	Zook silty clay loam	27	IIIw-2	31	Clayey Overflow	36	Moderately Wet	38

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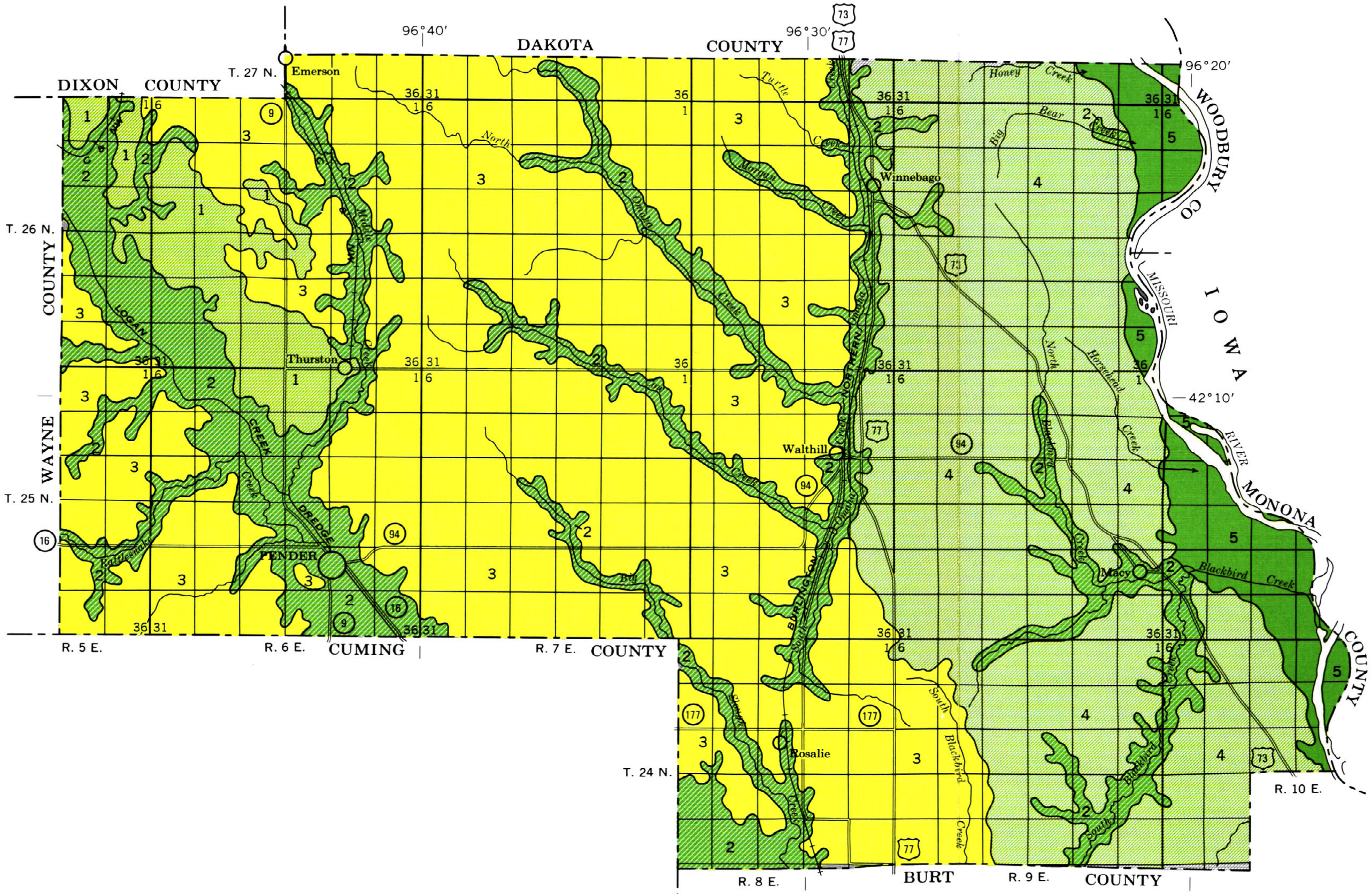
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
UNIVERSITY OF NEBRASKA CONSERVATION AND SURVEY DIVISION

GENERAL SOIL MAP

THURSTON COUNTY, NEBRASKA

Scale 1:190,080



SOIL ASSOCIATIONS *

1 — Moody-Nora-Thurman association: Well-drained, gently sloping to sloping, mixed silty and sandy soils on uplands

2 — Judson-Kennebec-Lamo association: Well drained to somewhat poorly drained, nearly level to gently sloping, silty soils along bottom lands and upland drainageways

3 — Moody-Nora-Judson association: Well-drained, nearly level to steep, silty soils on uplands

4 — Monona-Ida association: Well-drained, sloping to very steep, silty soils on uplands

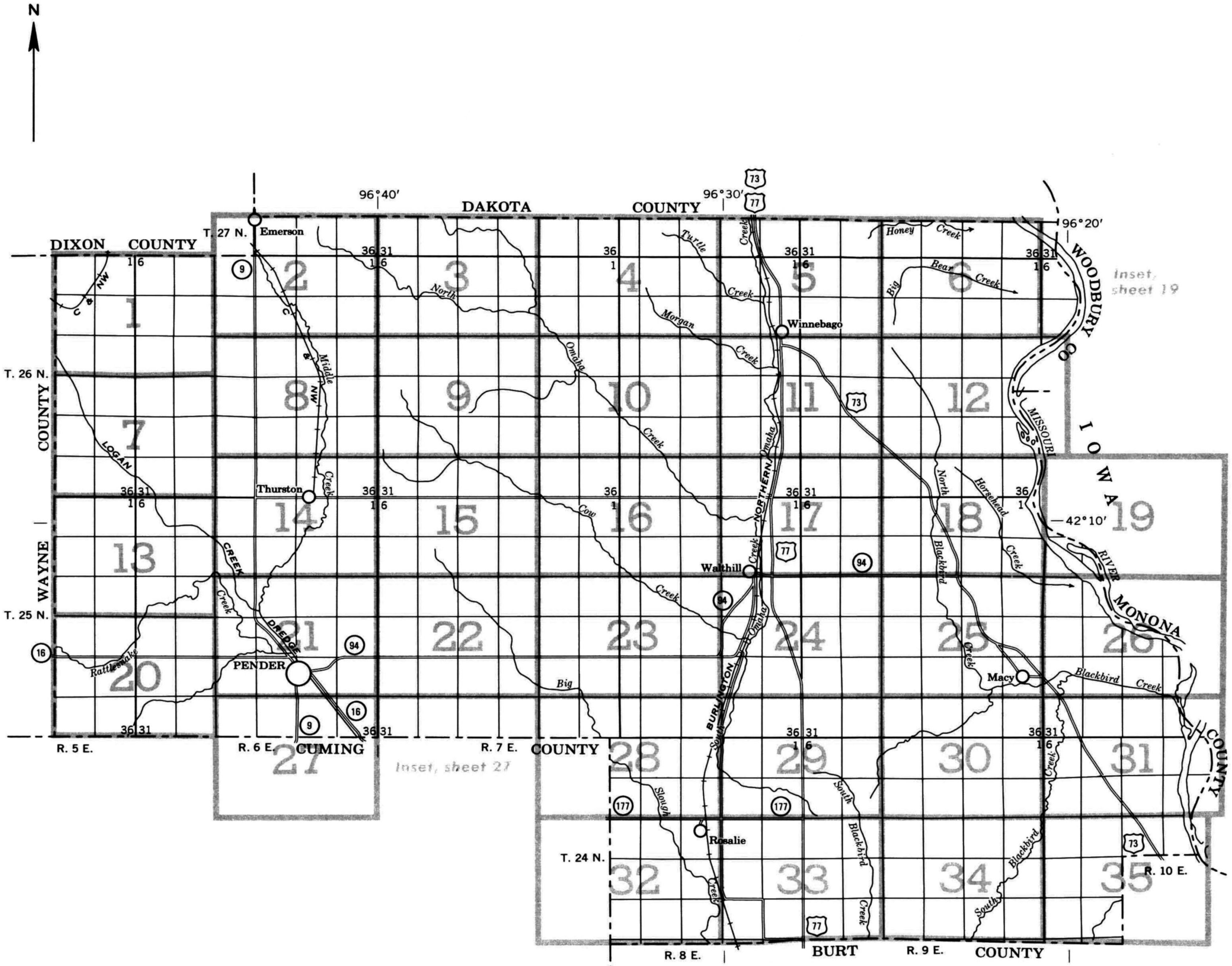
5 — Albaton-Haynie association: Poorly drained and moderately well drained, nearly level, clayey to loamy soils on river bottoms

* Texture named in soil associations is that of surface layer.

March 1971

NOTE—
This map is intended for general planning. Each delineation may contain soils having ratings different from those shown on the map. Use detailed soil maps for operational planning.

INDEX TO MAP SHEETS
THURSTON COUNTY, NEBRASKA



SOIL LEGEND

Each soil symbol consists of letters or of letters and numbers; for example, Am, BM, CfB2, 2La. The last capital letter A, B, C, D, E, or F, shows the slope if slope forms part of the soil name. A final number, 2, in the symbol shows that the soil is eroded.

SYMBOL	NAME
Ak	Albaton silty clay
Am	Albaton silty clay loam
BdD2	Burchard clay loam, 11 to 17 percent slopes, eroded
BLg	Rough broken land
BM	Belfore-Moody silty clay loams, 0 to 1 percent slopes
BnC	Burchard silt loam, 5 to 11 percent slopes
BnD	Burchard silt loam, 11 to 17 percent slopes
CfB2	Crofton silt loam, 1 to 7 percent slopes, eroded
CfC2	Crofton silt loam, 7 to 11 percent slopes, eroded
CfD2	Crofton silt loam, 11 to 17 percent slopes, eroded
CfE2	Crofton silt loam, 17 to 31 percent slopes, eroded
Ct	Colo silty clay loam
GL	Gullied land
He	Haynie silt loam
IdC2	Ida silt loam, 7 to 11 percent slopes, eroded
IdD	Ida silt loam, 11 to 17 percent slopes
IdD2	Ida silt loam, 11 to 17 percent slopes, eroded
IdE	Ida silt loam, 17 to 31 percent slopes
IdE2	Ida silt loam, 17 to 31 percent slopes, eroded
JuA	Judson silt loam, 0 to 2 percent slopes
JuB	Judson silt loam, 2 to 7 percent slopes
Ke	Kennebec silt loam
2La	Lamo silt loam, overwash
Lb	Lamo silty clay loam
Lk	Luton silty clay
Ls	Luton silty clay loam
M	Marsh
Mc	McPaul silt loam
MnB	Monona silt loam, 1 to 7 percent slopes
MnB2	Monona silt loam, 1 to 7 percent slopes, eroded
MnC	Monona silt loam, 7 to 11 percent slopes
MnC2	Monona silt loam, 7 to 11 percent slopes, eroded
MnD	Monona silt loam, 11 to 17 percent slopes
MnD2	Monona silt loam, 11 to 17 percent slopes, eroded
MnF	Monona silt loam, 17 to 31 percent slopes
Mo	Moody silty clay loam, 0 to 1 percent slopes
MoB	Moody silty clay loam, 1 to 7 percent slopes
MoB2	Moody silty clay loam, 1 to 7 percent slopes, eroded
MoC	Moody silty clay loam, 7 to 11 percent slopes
MoC2	Moody silty clay loam, 7 to 11 percent slopes, eroded
MyC	Moody fine sandy loam, 7 to 11 percent slopes
NoB2	Nora silt loam, 1 to 7 percent slopes, eroded
NoC	Nora silt loam, 7 to 11 percent slopes
NoC2	Nora silt loam, 7 to 11 percent slopes, eroded
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NoE2	Nora silt loam, 17 to 31 percent slopes, eroded
Oc	Onawa silty clay
ON	Onawa and Haynie soils
OrB	Ortello fine sandy loam, 2 to 5 percent slopes
OrC2	Ortello fine sandy loam, 5 to 11 percent slopes, eroded
Rw	Riverwash
Sb	Sarpy soils
StE	Steinauer soils, 11 to 30 percent slopes
Sy	Silty alluvial land
TcB	Thurman loamy sand, 1 to 7 percent slopes
TxE	Thurman soils, 7 to 17 percent slopes
Wx	Wet alluvial land
Zc	Zook silty clay
Zo	Zook silty clay loam

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Dual
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Tunnel

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches (CANAL)

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Alluvial fan

Drainage end

RELIEF

Escarpments
- Bedrock
- Other

Prominent peak

Depressions, unclassified — Large, Small

SOIL SURVEY DATA

Soil boundary and symbol (Dx)

Gravel

Stoniness
- Stony
- Very stony

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

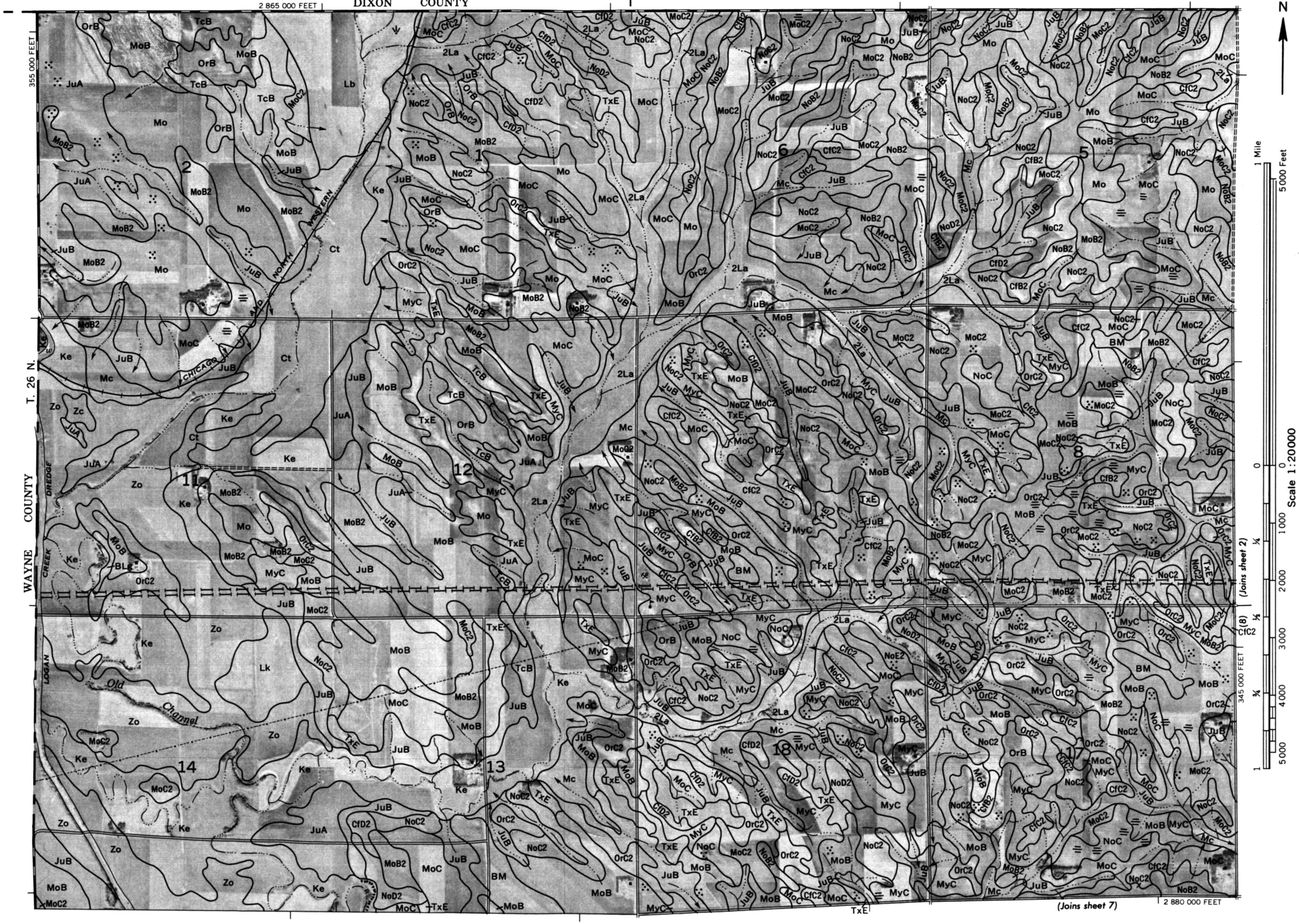
Blowout, wind erosion

Gully

Short steep slope

Soil map constructed 1970 by Cartographic Division, Soil Conservation Service, USDA, from 1965 aerial photographs. Controlled mosaic based on Nebraska plane coordinate system, north zone, Lambert conformal conic projection, 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 1



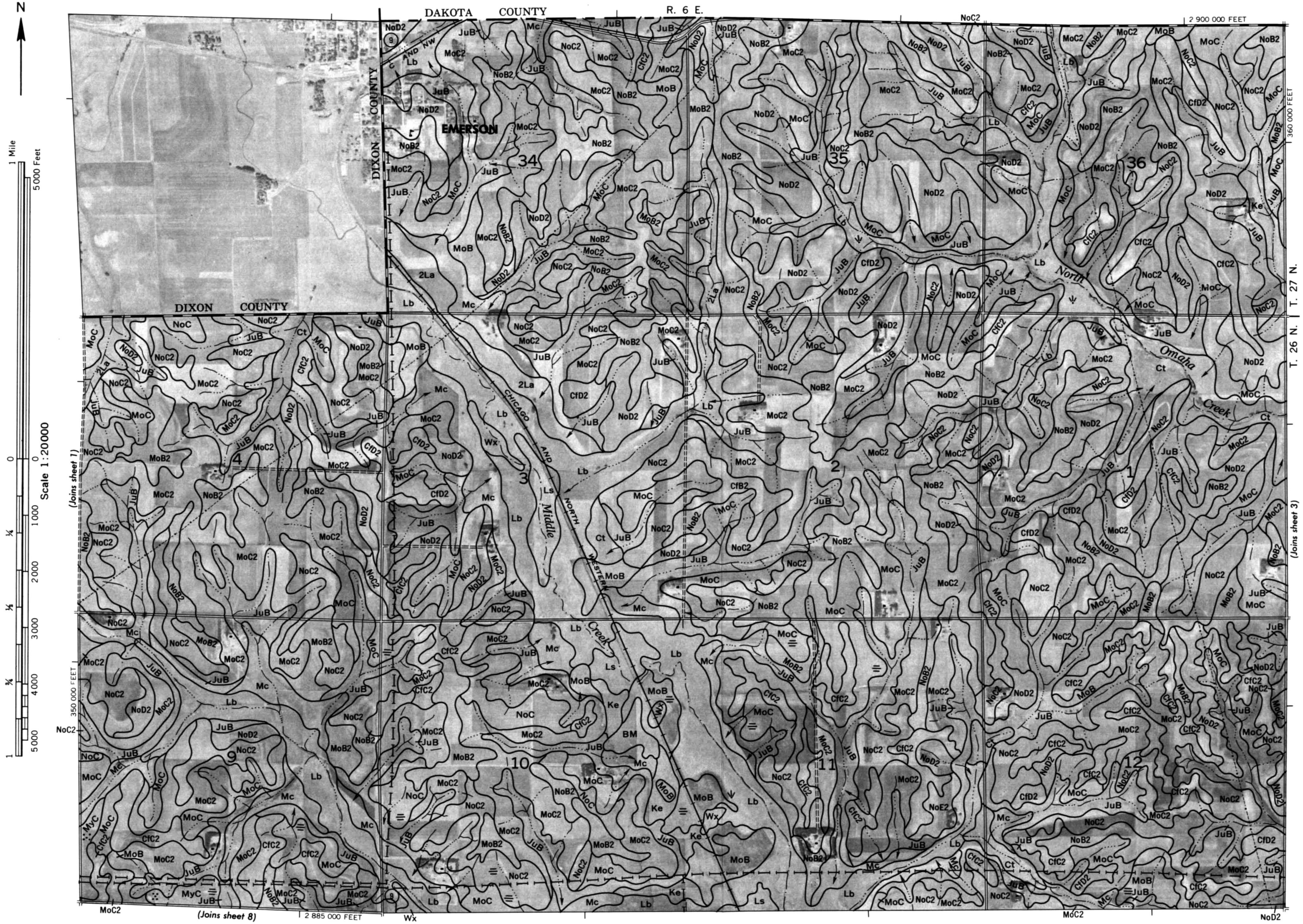
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 1

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 2



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THURSTON COUNTY, NEBRASKA NO. 2

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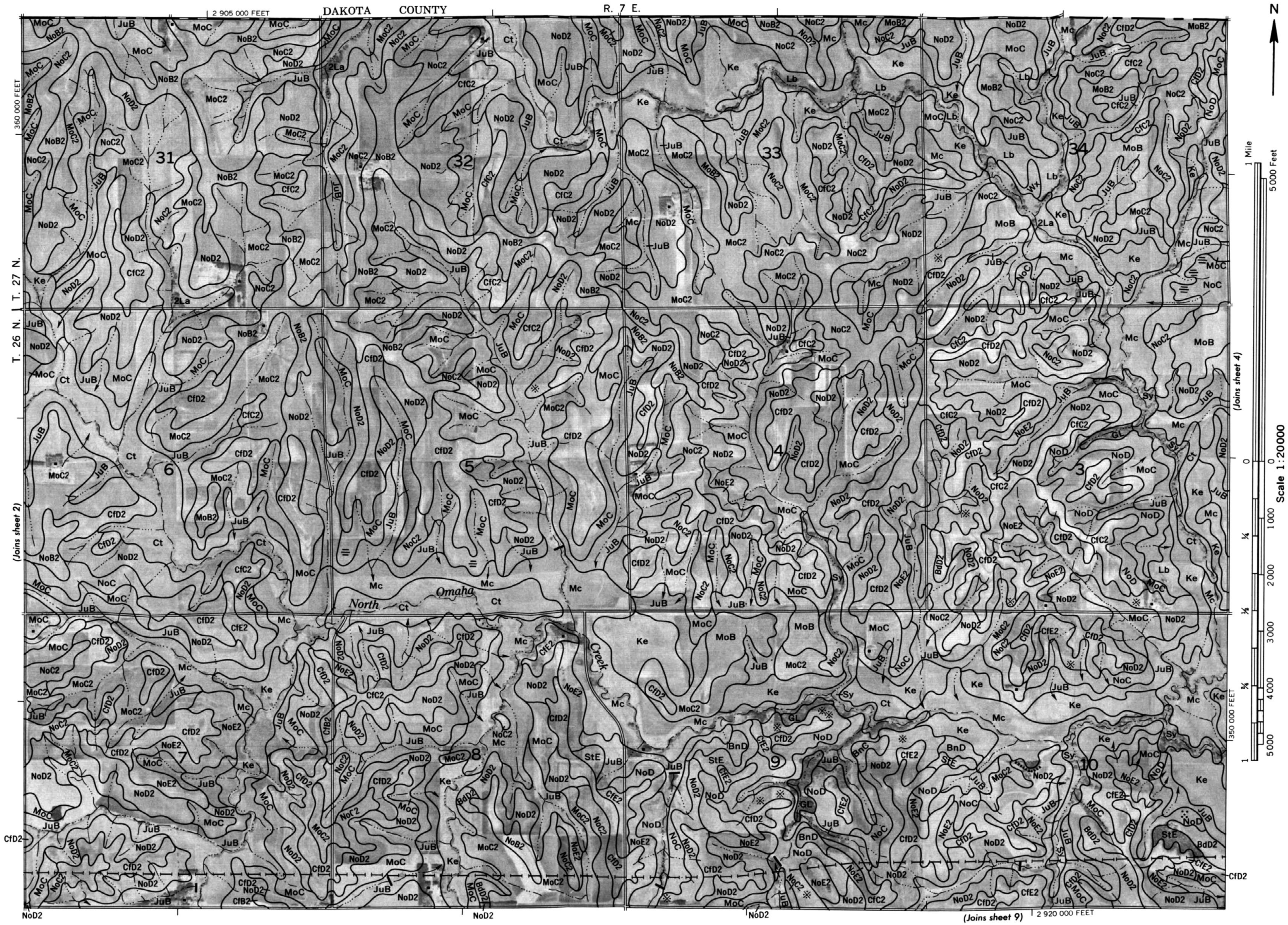
Land division corners are approximately positioned on this map.



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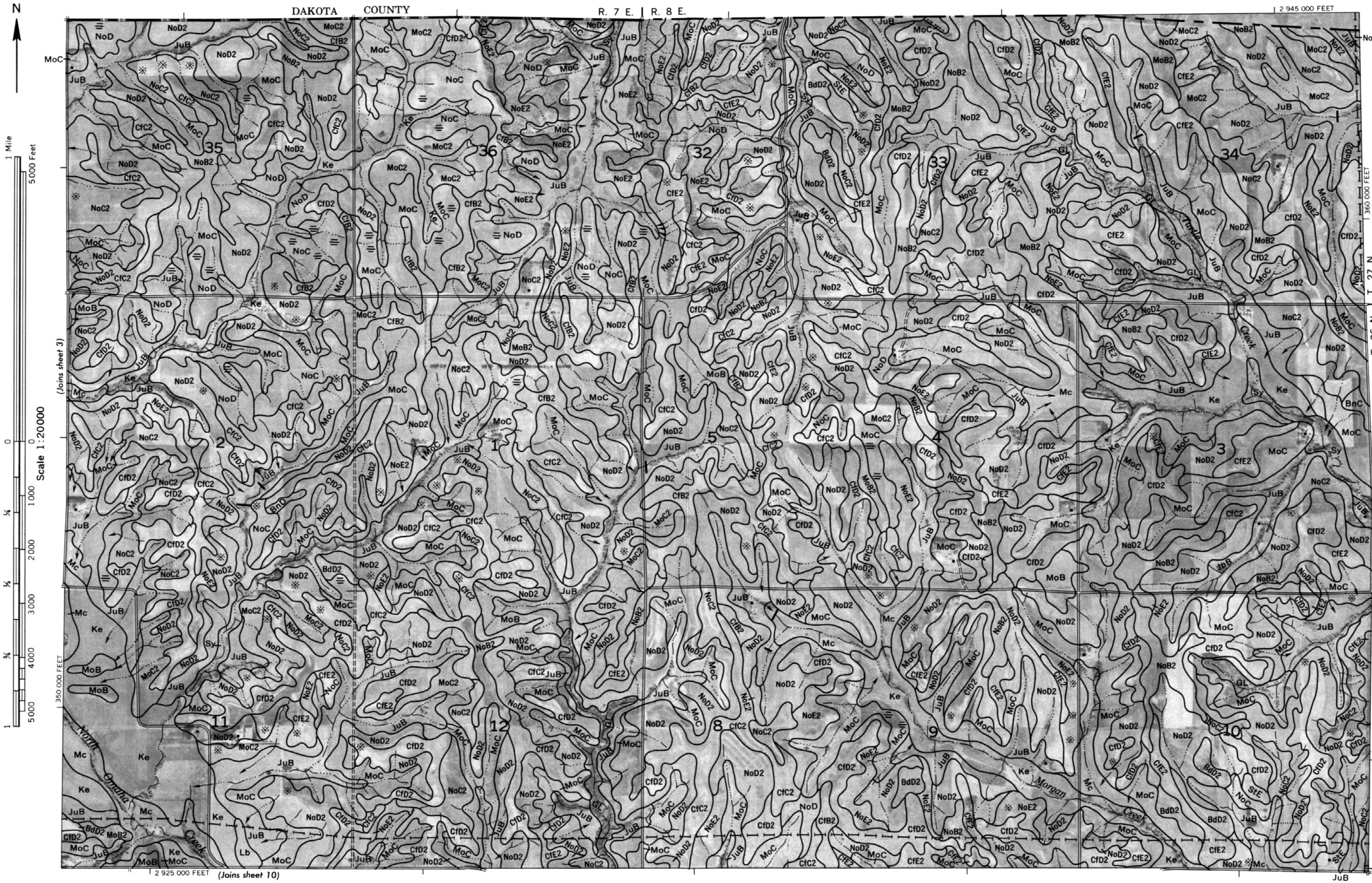
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 3

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 4



THURSTON COUNTY, NEBRASKA NO. 4

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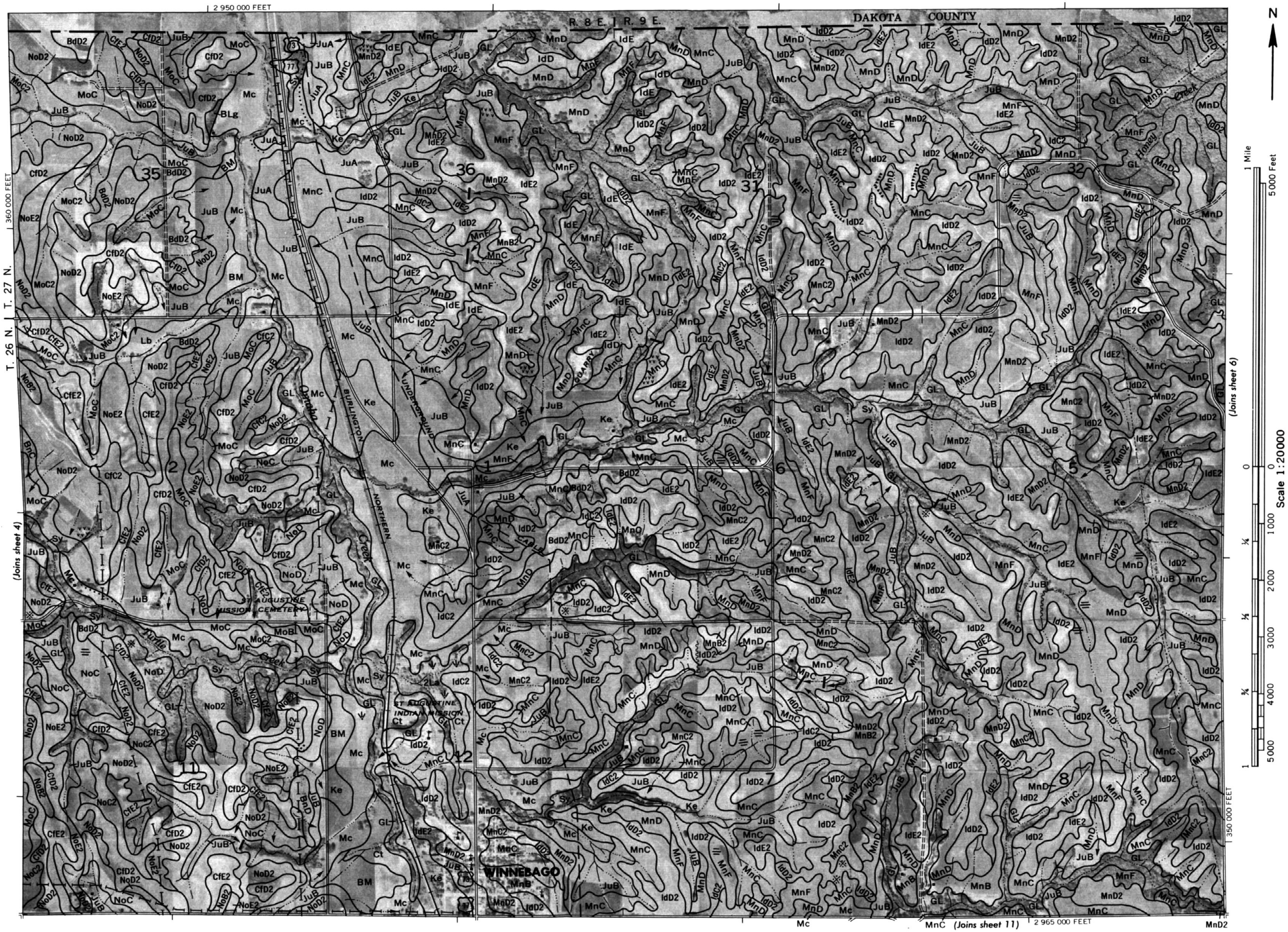
Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum

(5)



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 5

N

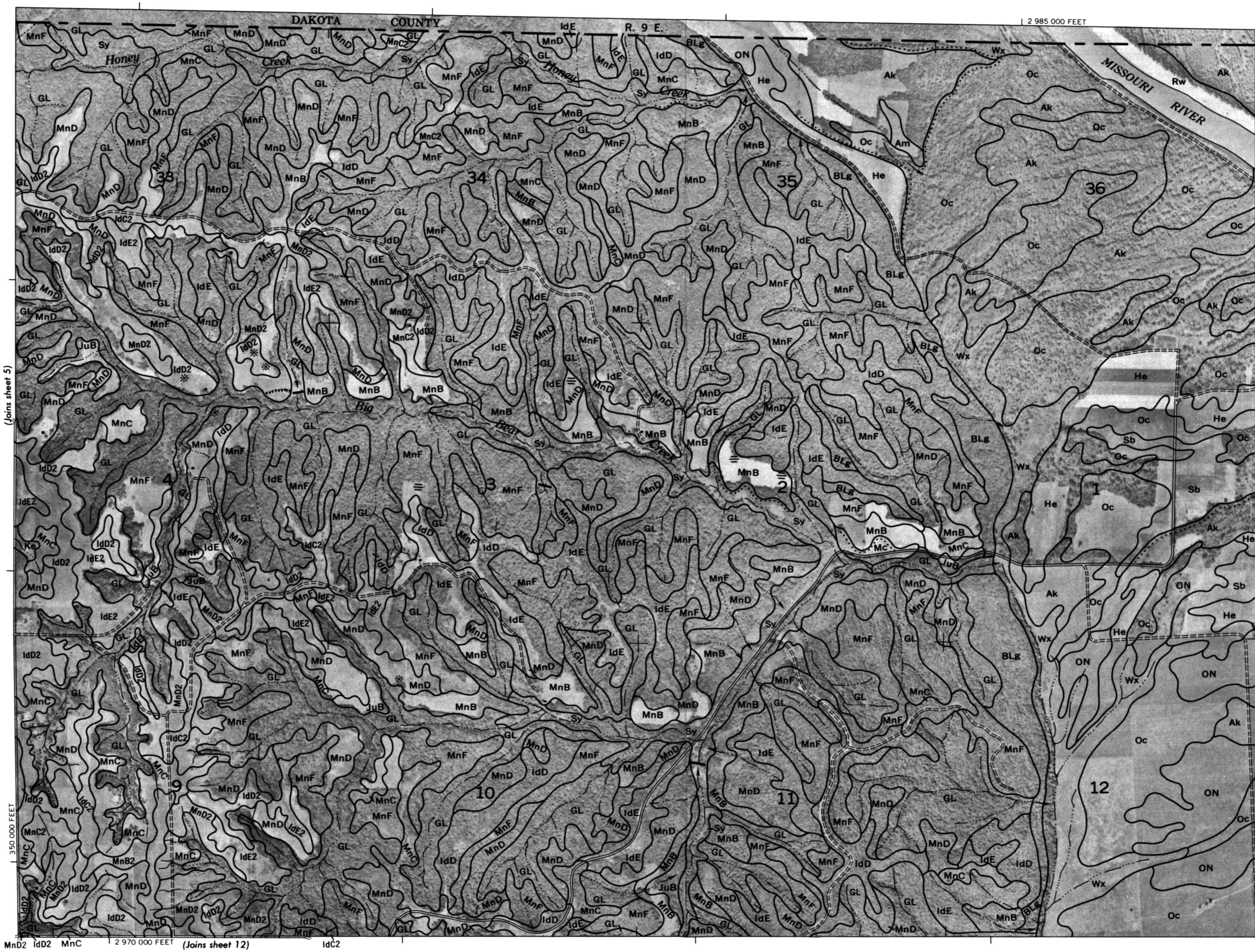
1 Mile

5000 Feet

Scale 1:20000

0 ¼ ½ ¾ 1

0 1000 2000 3000 4000 5000

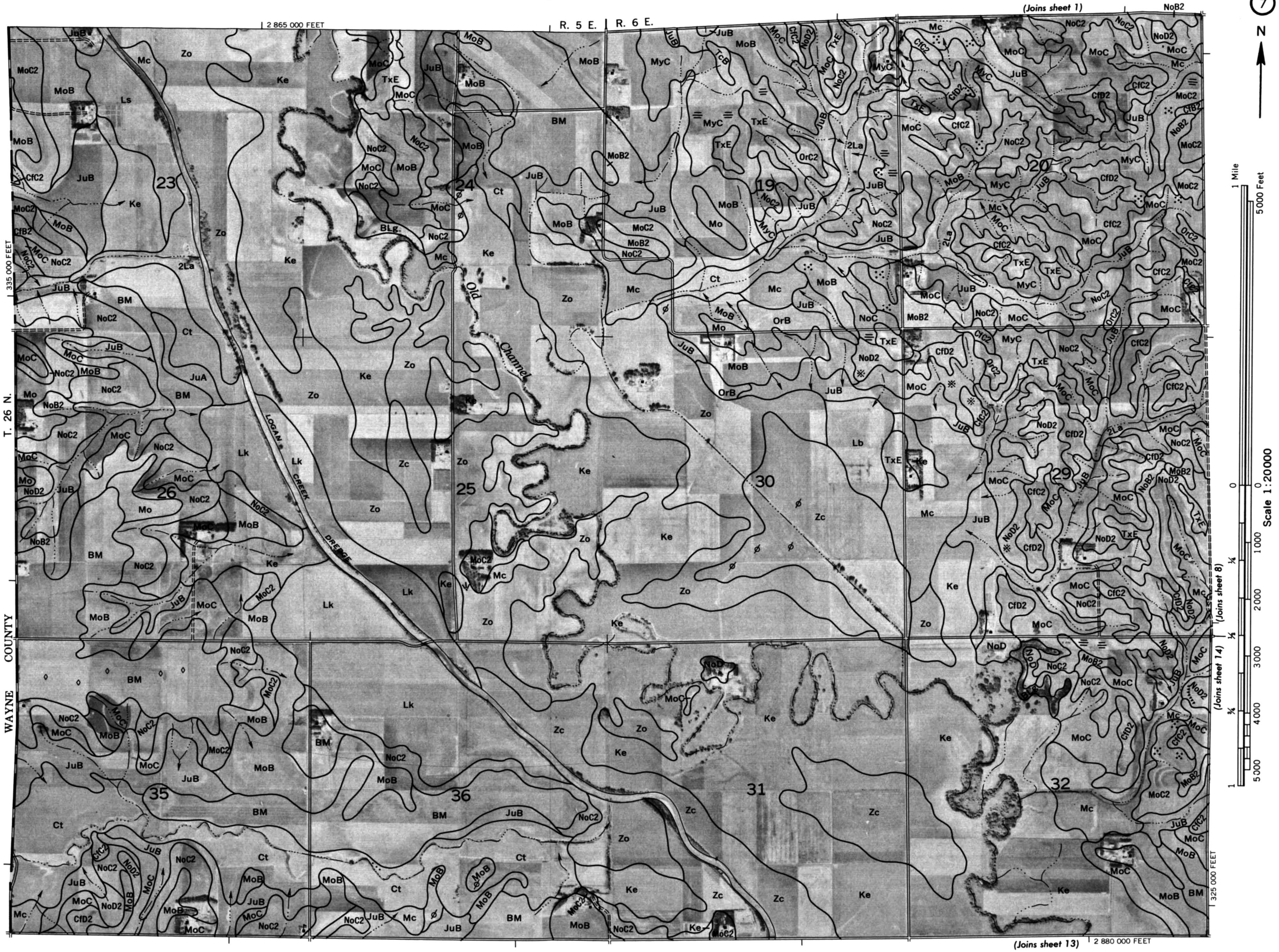


THURSTON COUNTY, NEBRASKA NO. 6

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

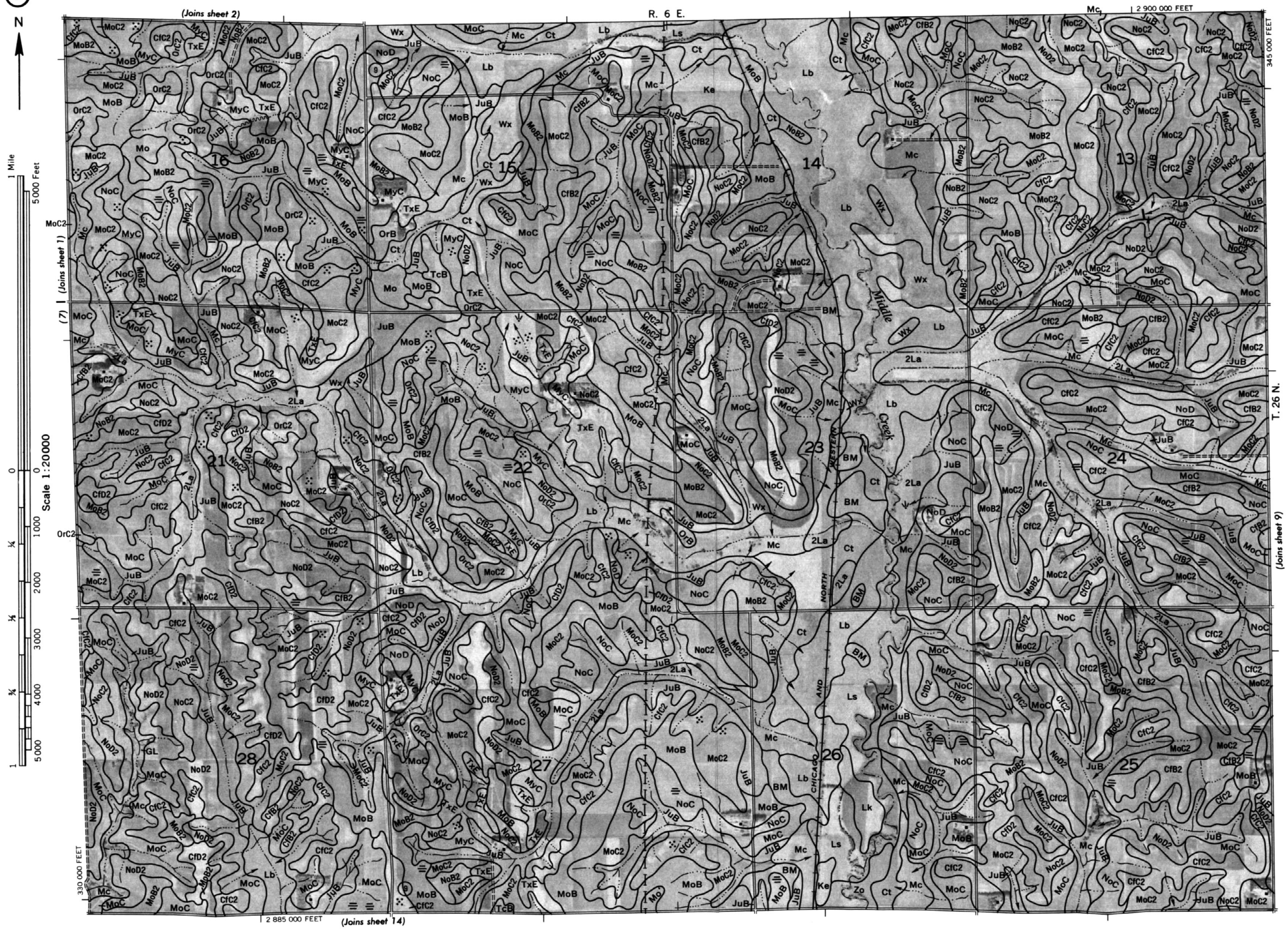
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 7

8

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 8



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 8

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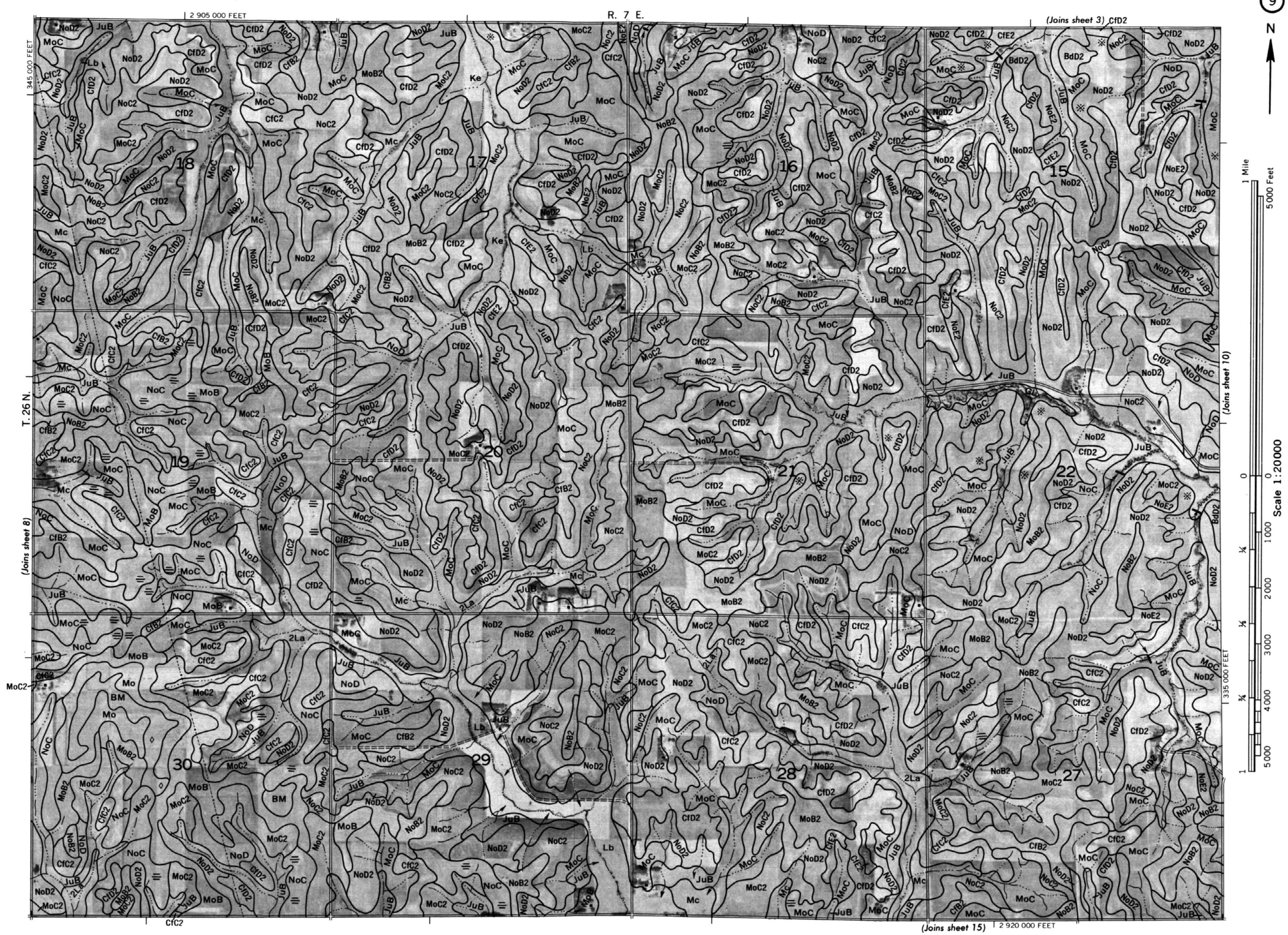

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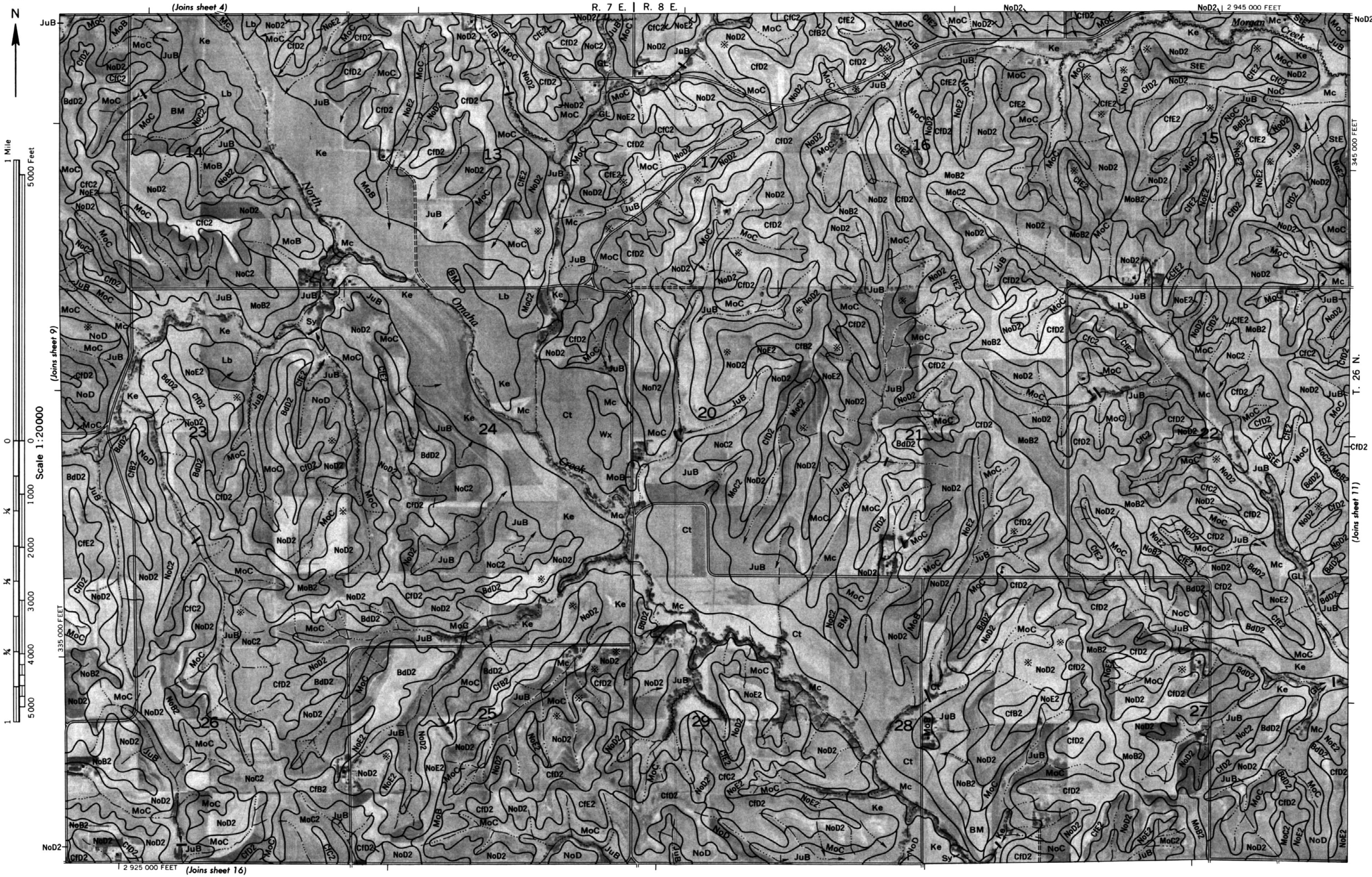
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 9

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

(10)

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 10



THURSTON COUNTY, NEBRASKA NO. 10

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

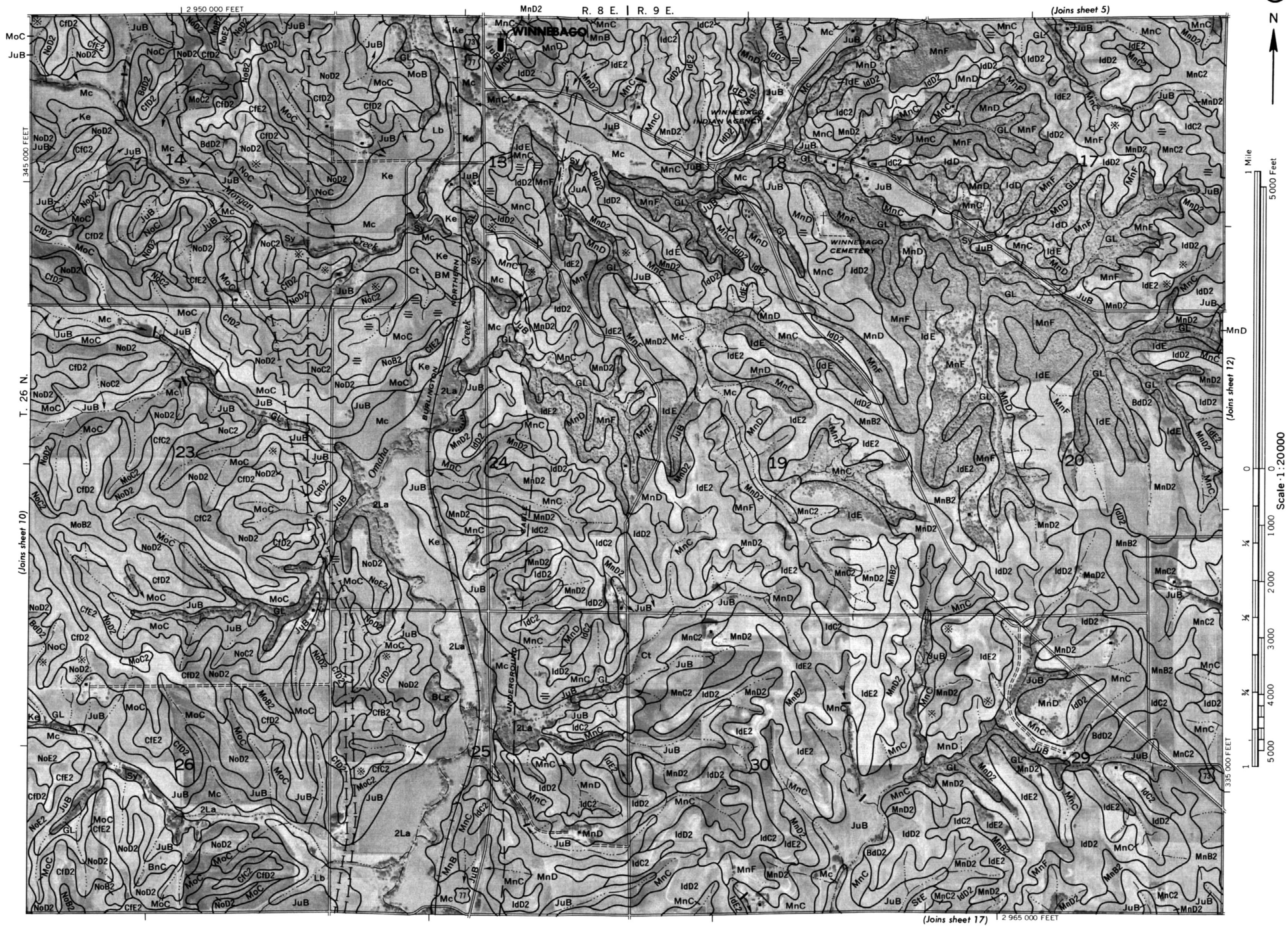
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

11

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 11



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 12

THURSTON COUNTY, NEBRASKA NO. 12

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

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Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 13

2 865 000 FEET

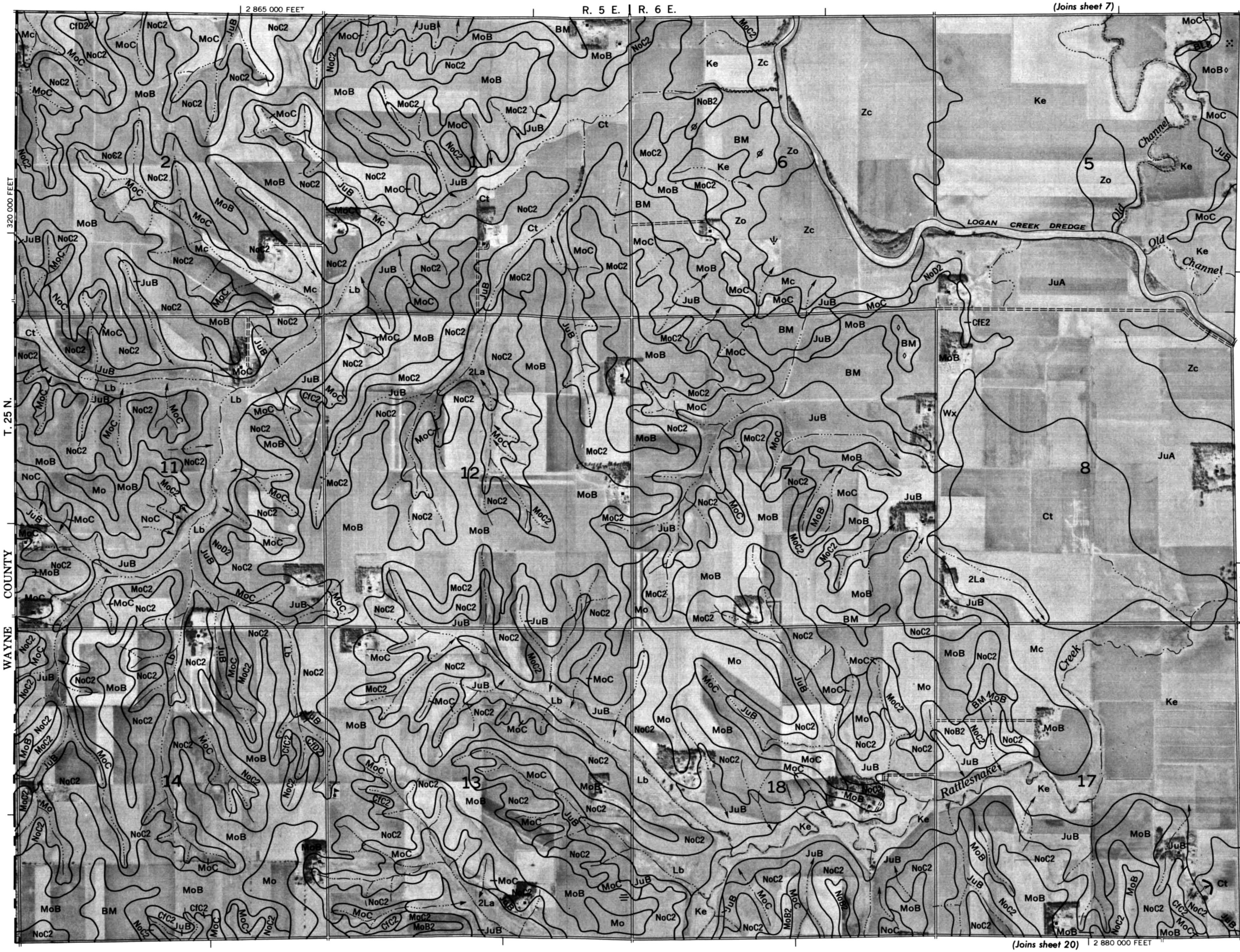
R. 5 E. | R. 6 E.

(Joins sheet 7)

320 000 FEET

T. 25 N.

WAYNE COUNTY



(Joins 14)

(Joins sheet 21)

310 000 FEET

(Joins sheet 20)

2 880 000 FEET

N

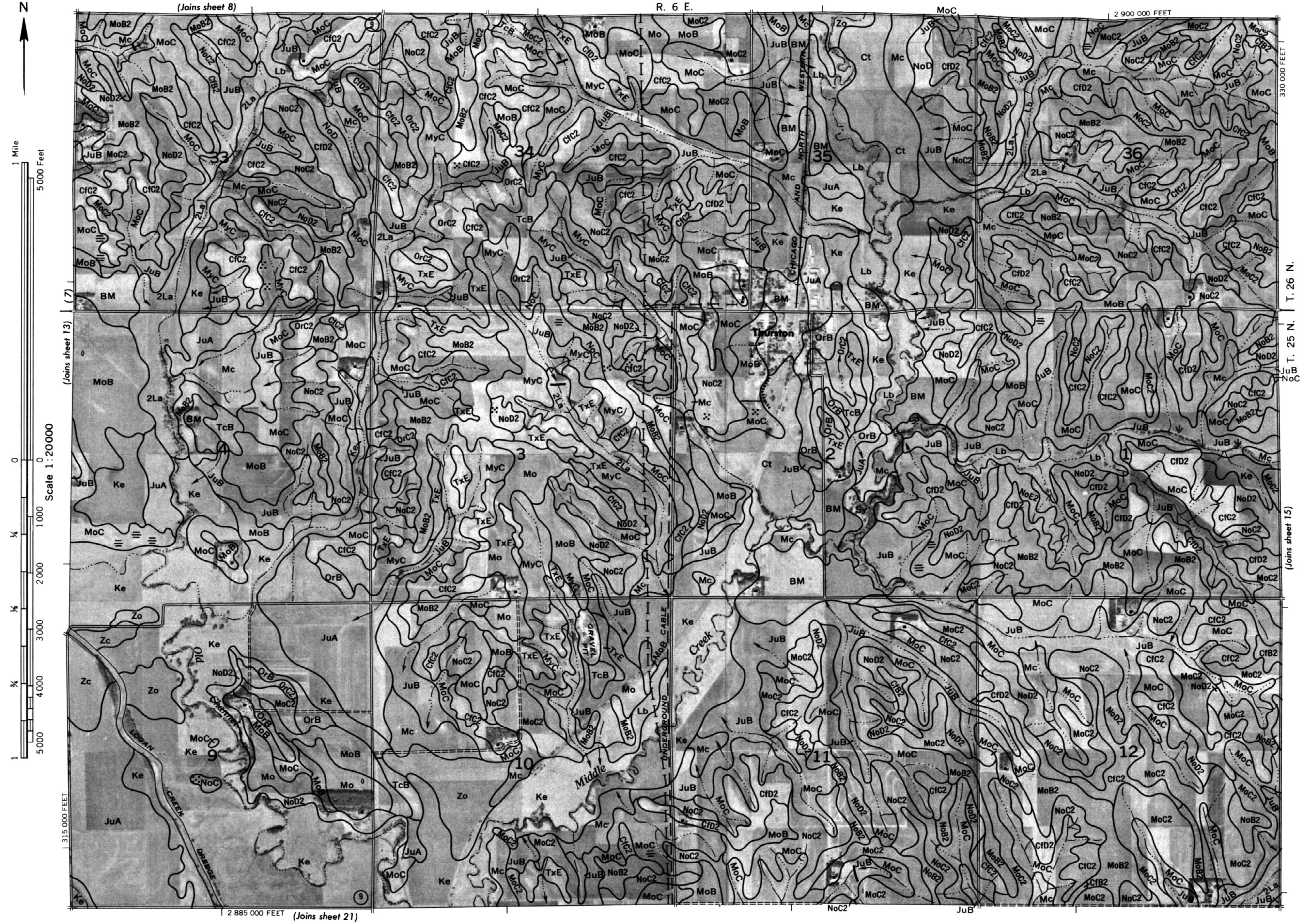
1 Mile

5000 Feet

Scale 1:20000

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 14



THURSTON COUNTY, NEBRASKA NO. 14

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

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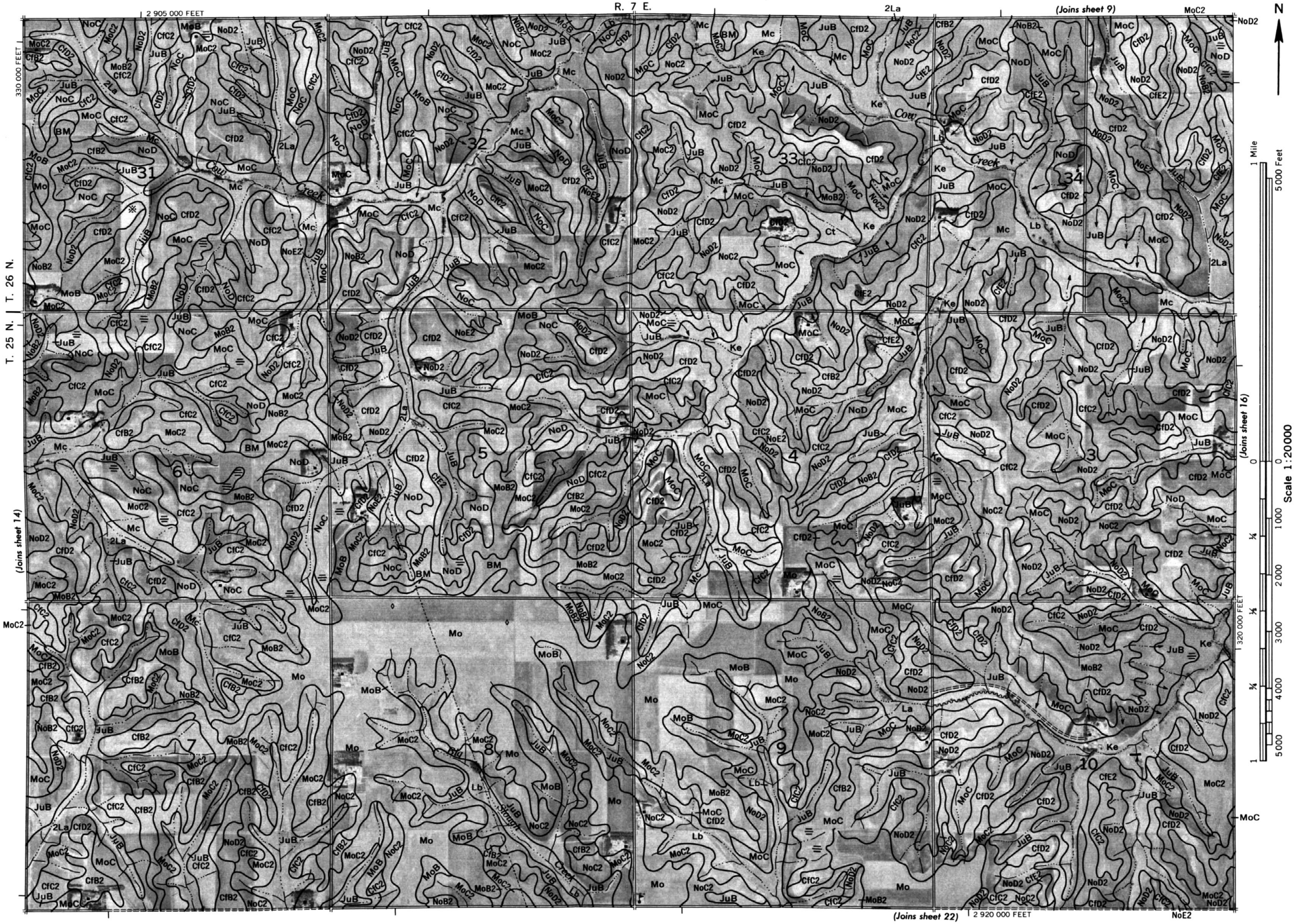
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

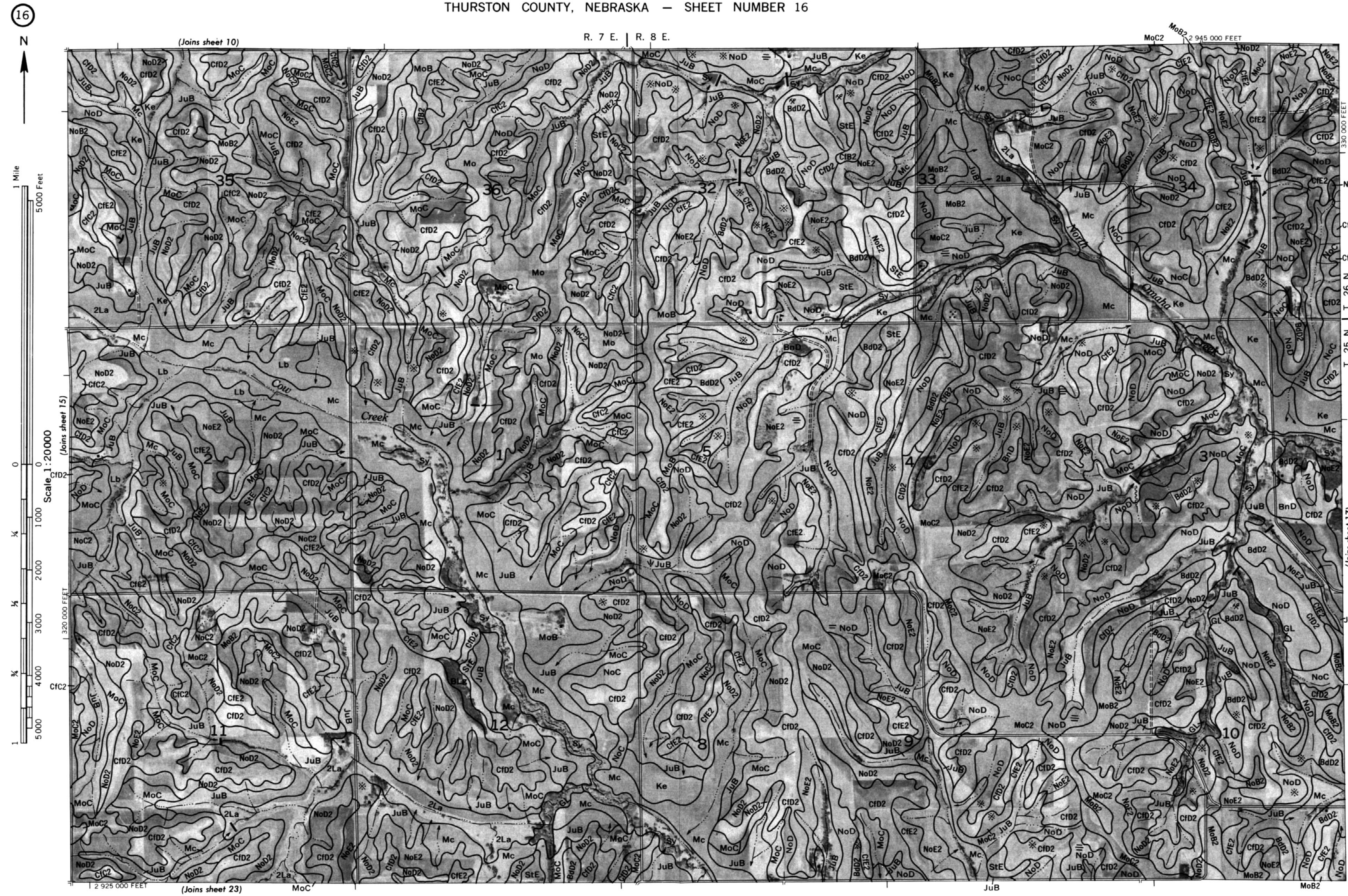
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 15



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 16

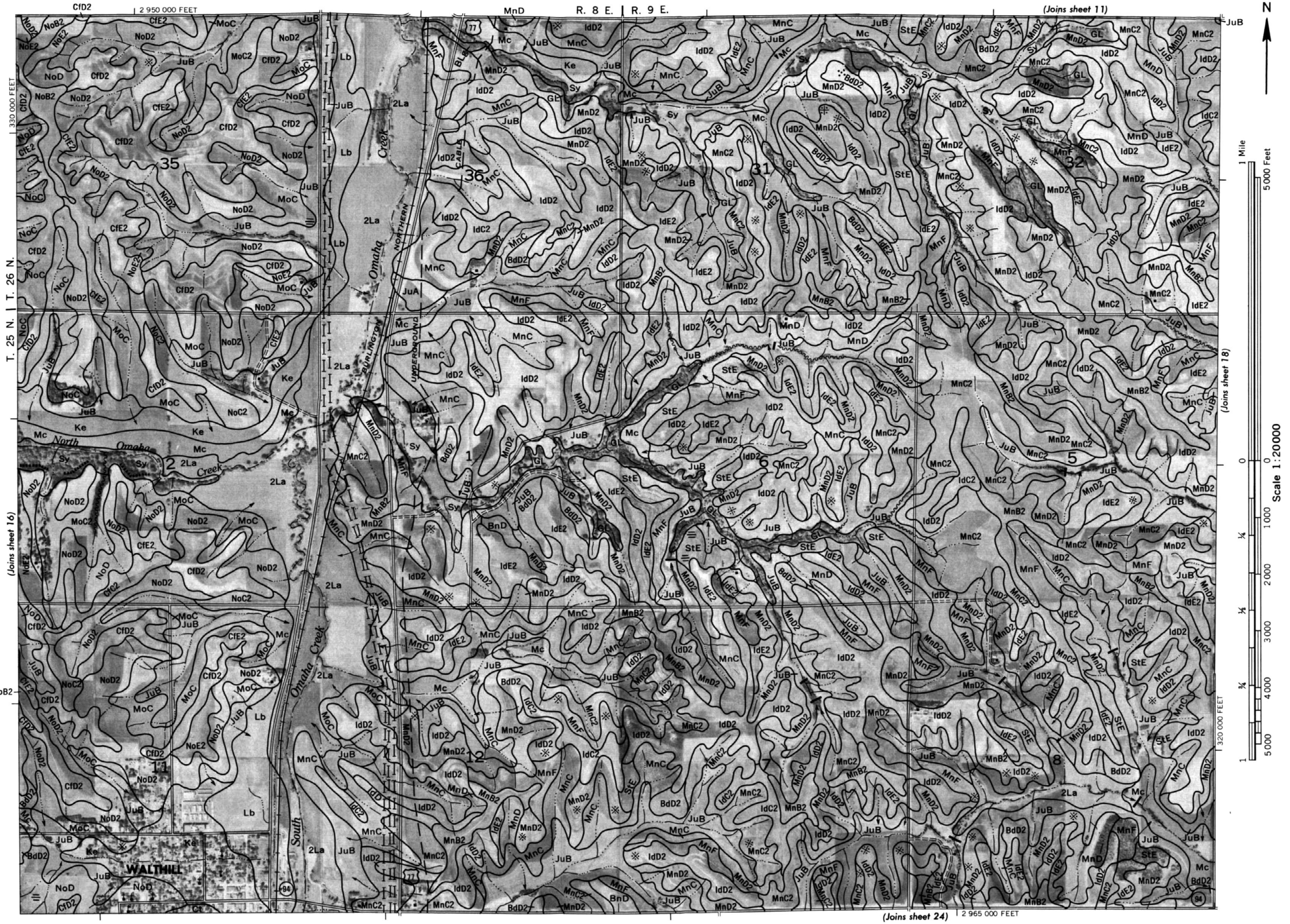


THURSTON COUNTY, NEBRASKA NO. 16

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 17

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 18

THURSTON COUNTY, NEBRASKA NO. 18

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

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Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

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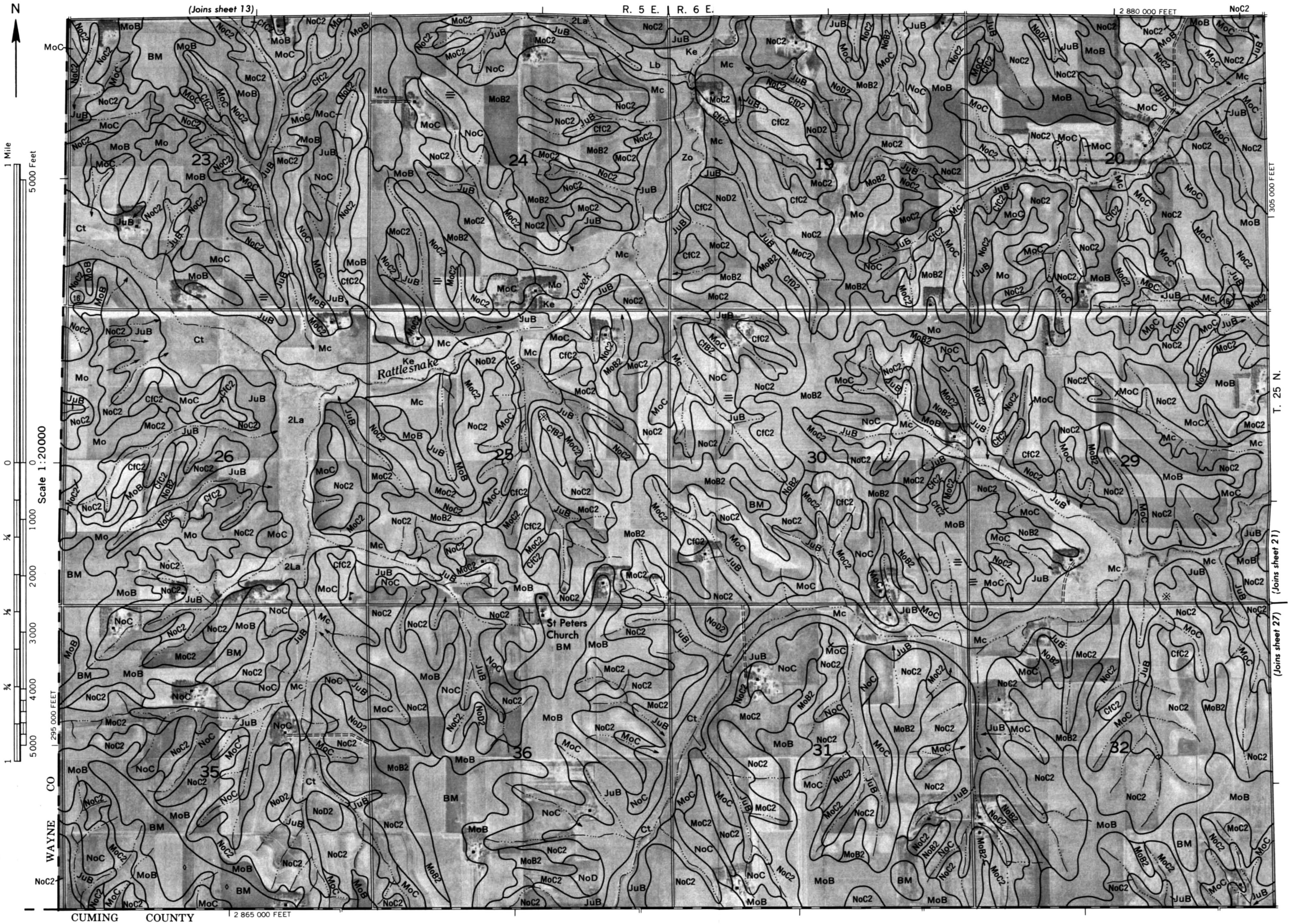
THURSTON COUNTY, NEBRASKA NO. 19

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 20



THURSTON COUNTY, NEBRASKA NO. 20

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

(21)

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

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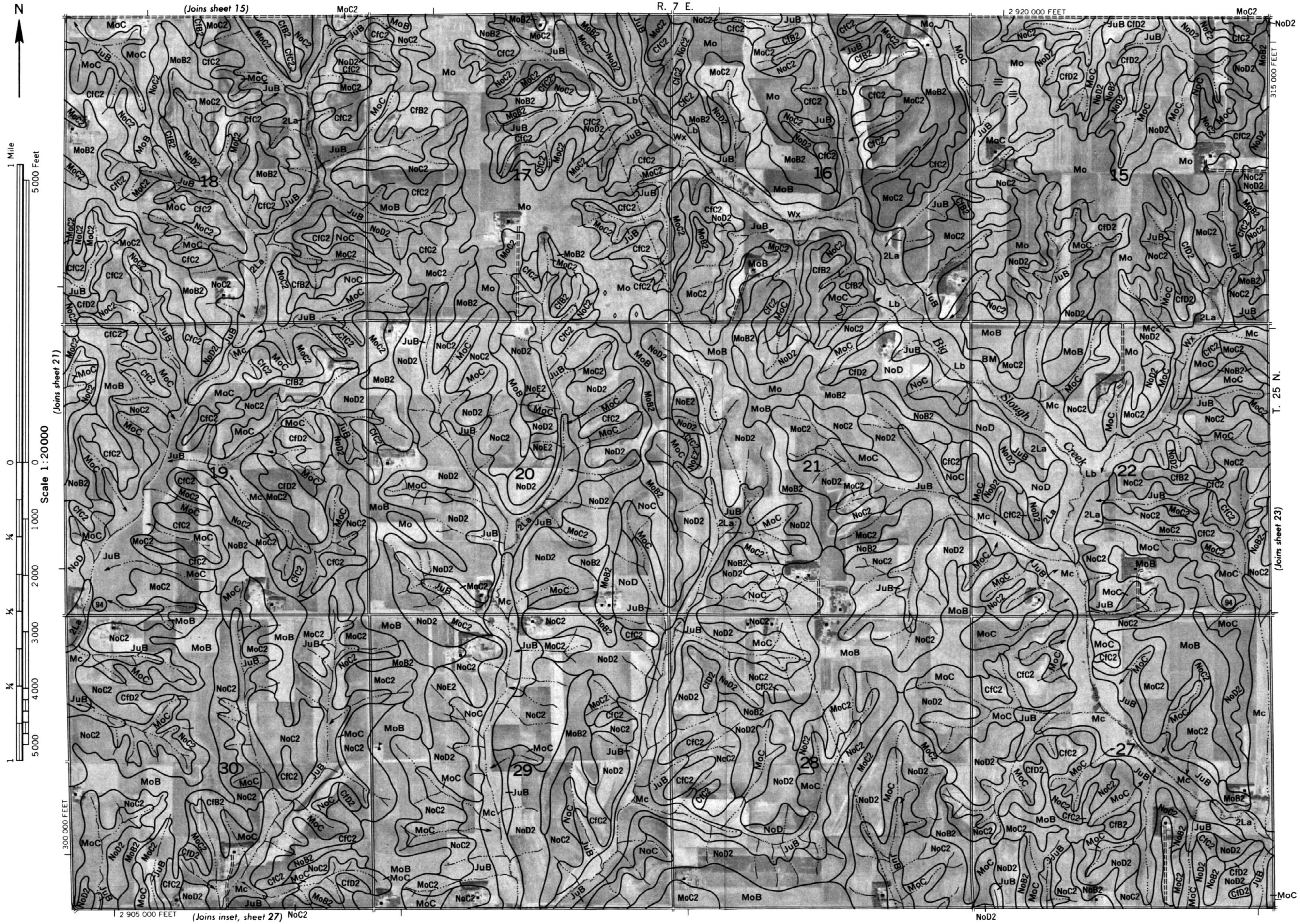
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 21

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 22



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 22

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

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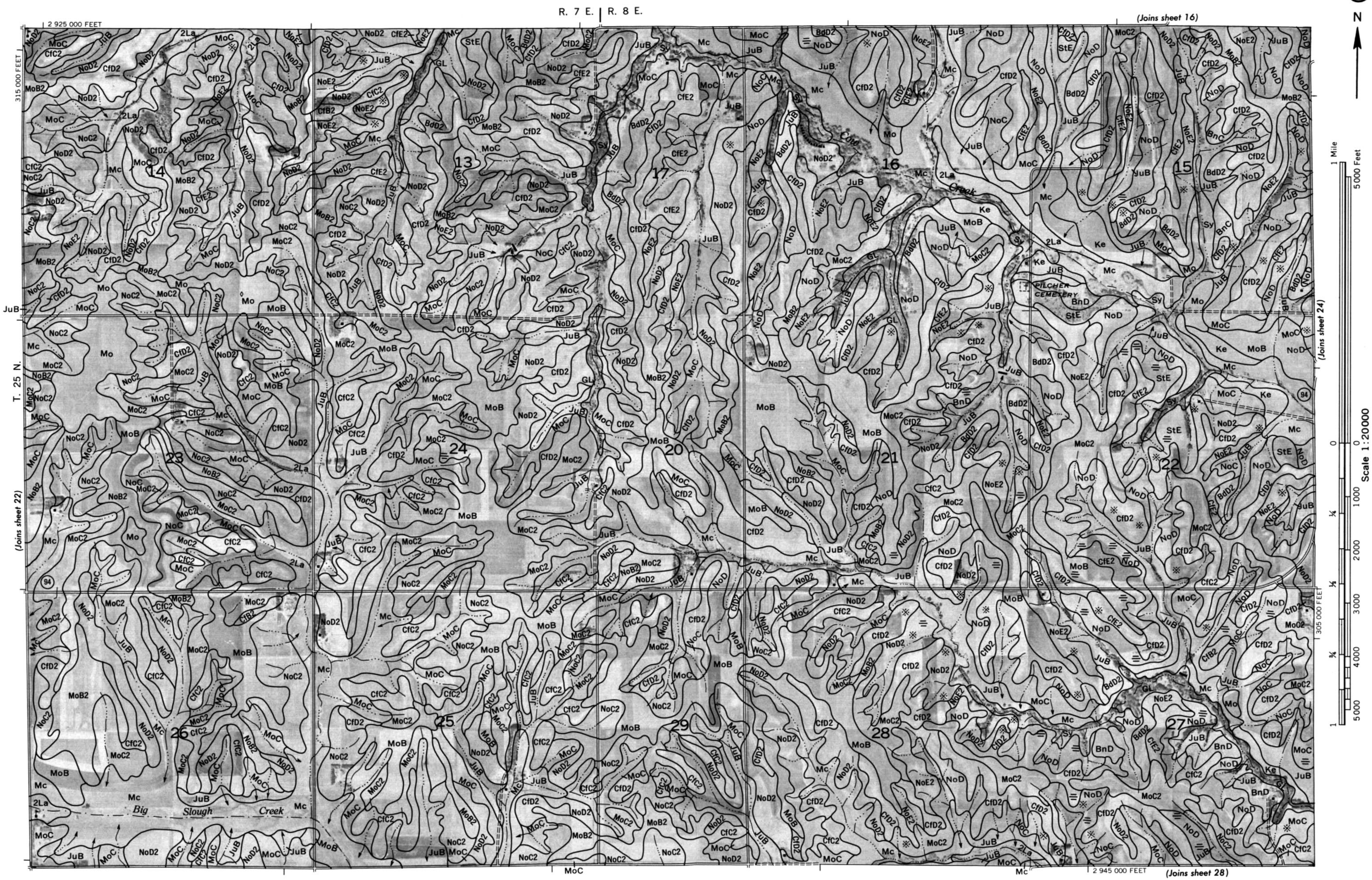

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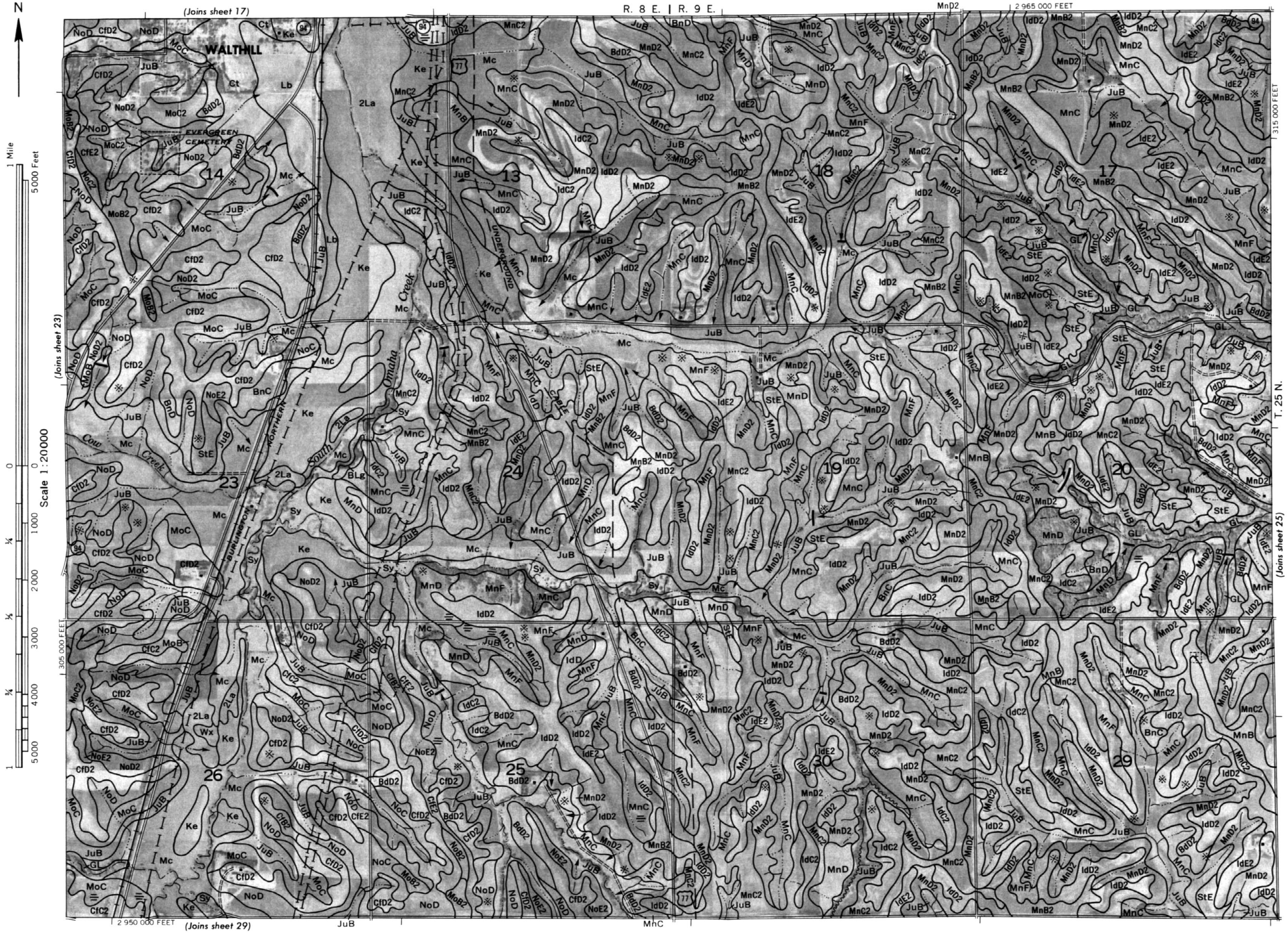
THURSTON COUNTY, NEBRASKA NO. 23

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 24



THURSTON COUNTY, NEBRASKA NO. 24

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Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone, 1927 North American datum.

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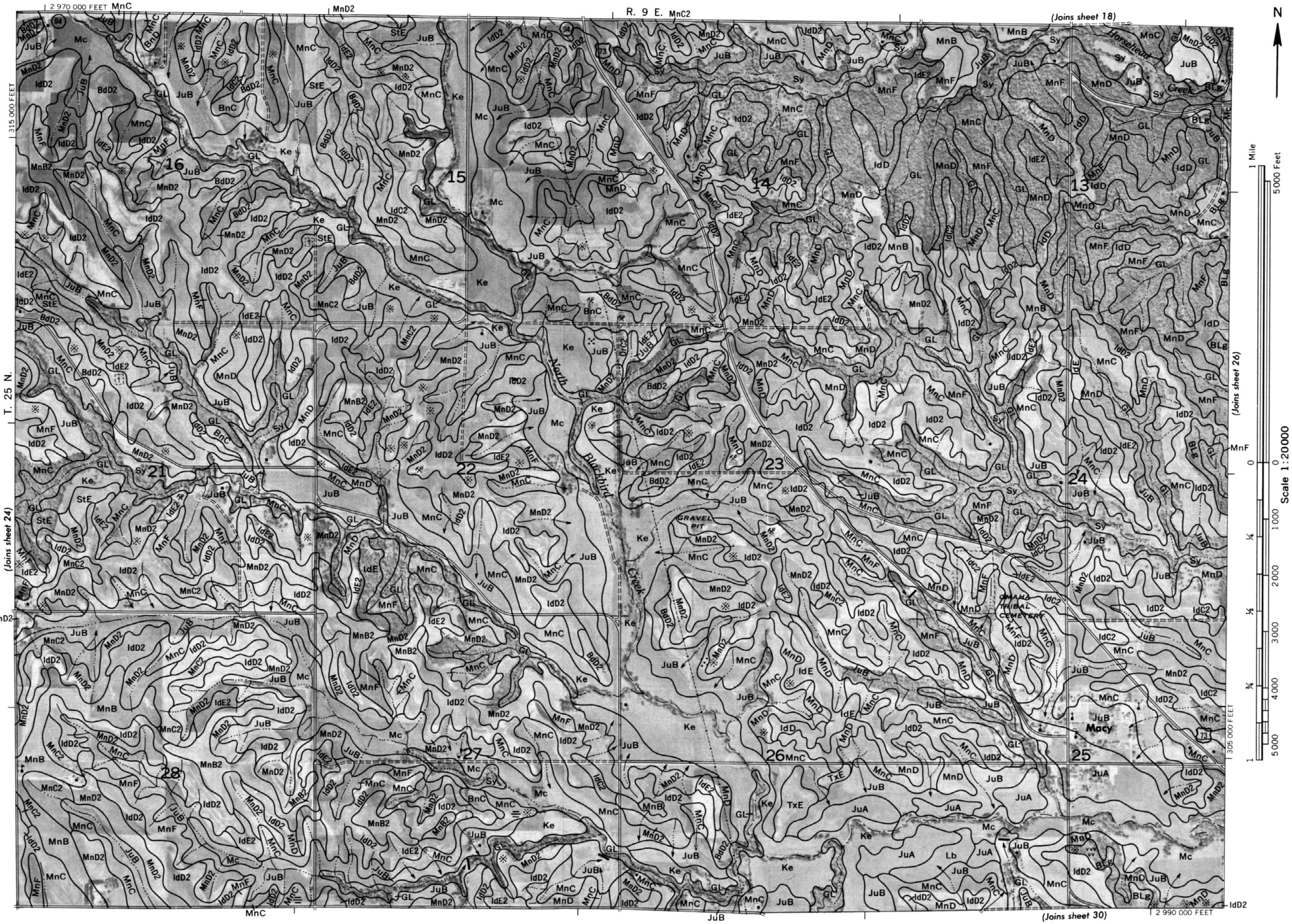
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 25



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 26

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 26

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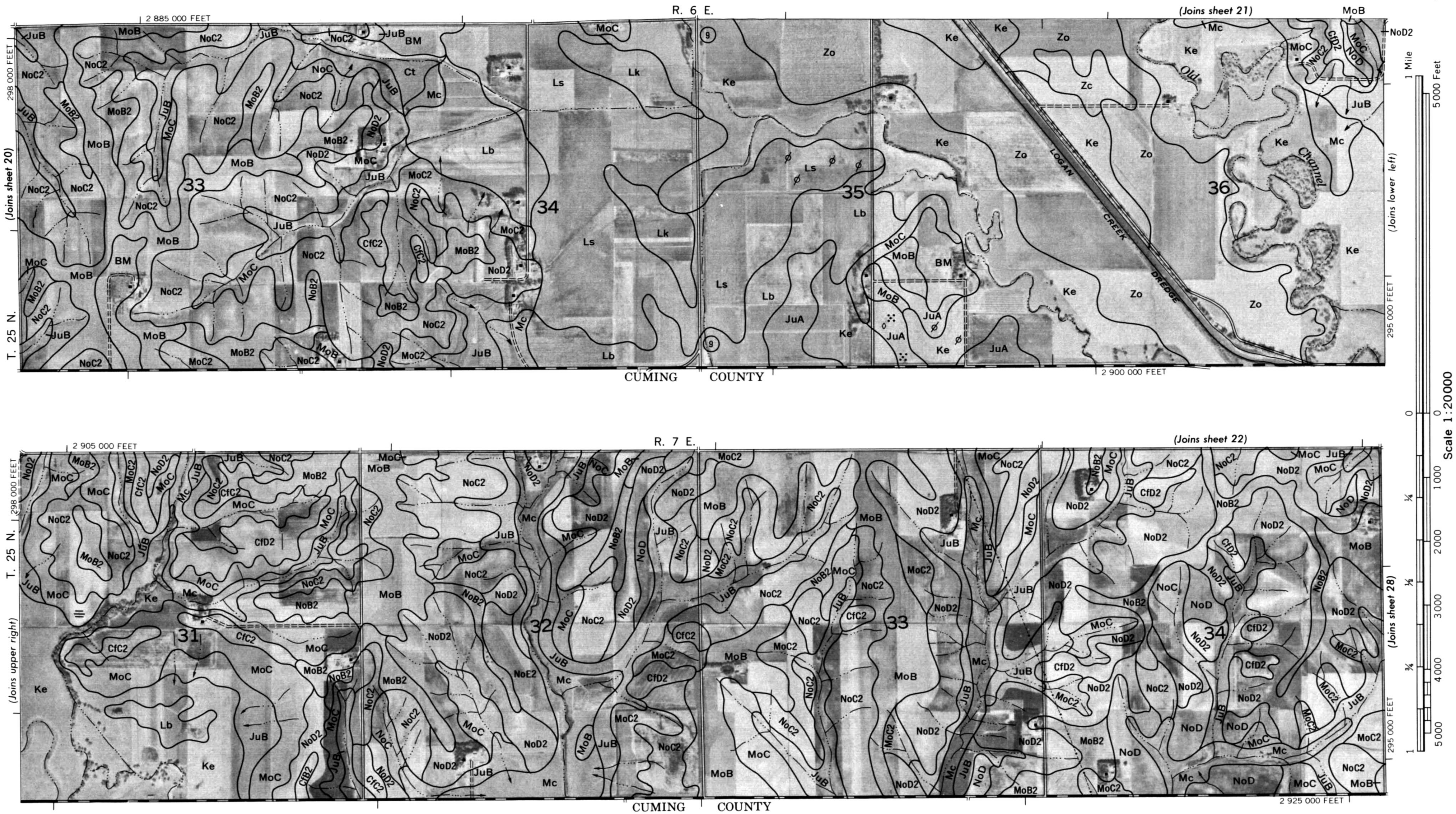


3000 AND 5000 - FOOT GRID TICKS

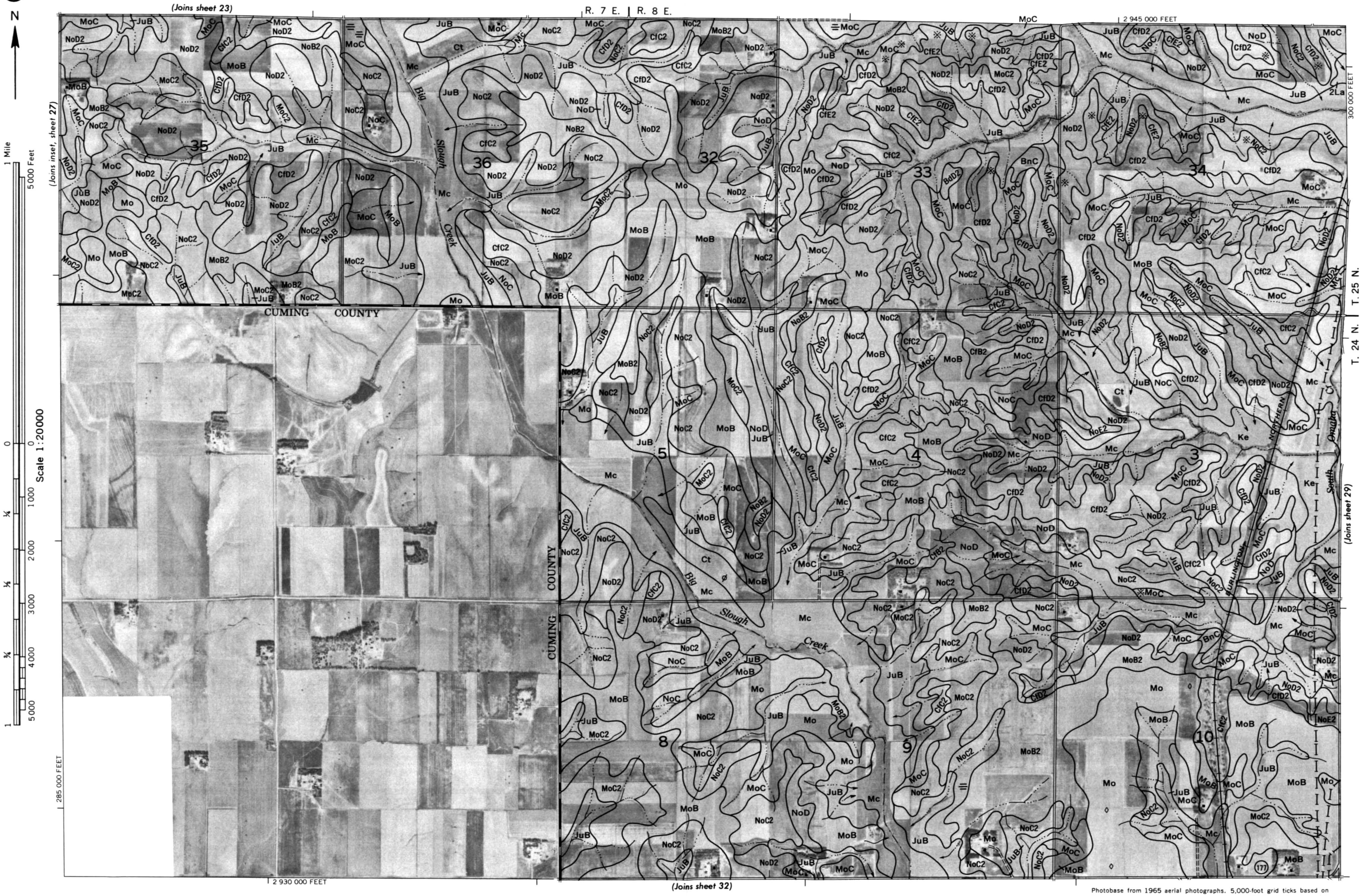
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 27

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 28

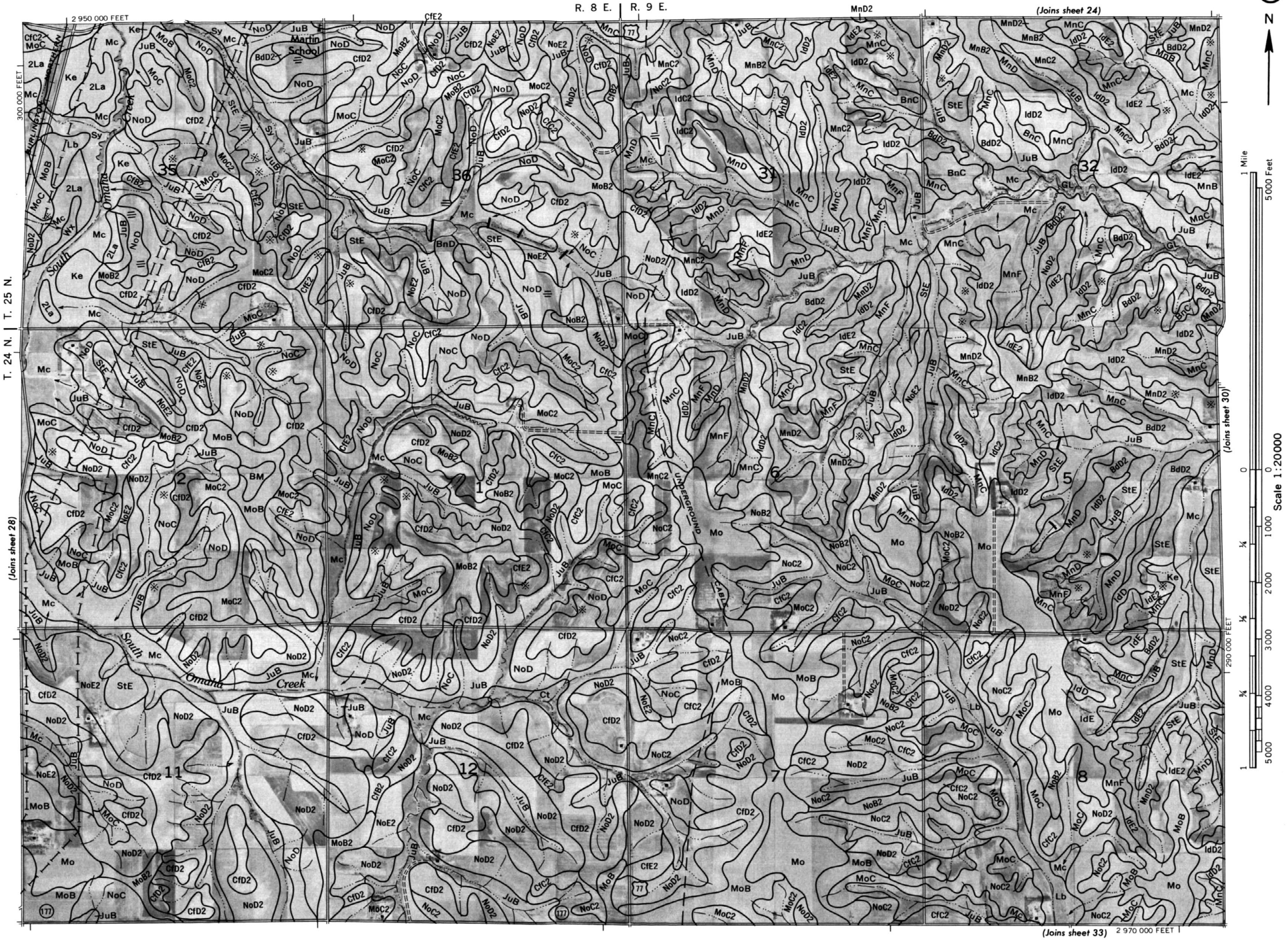


THURSTON COUNTY, NEBRASKA NO. 28

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.



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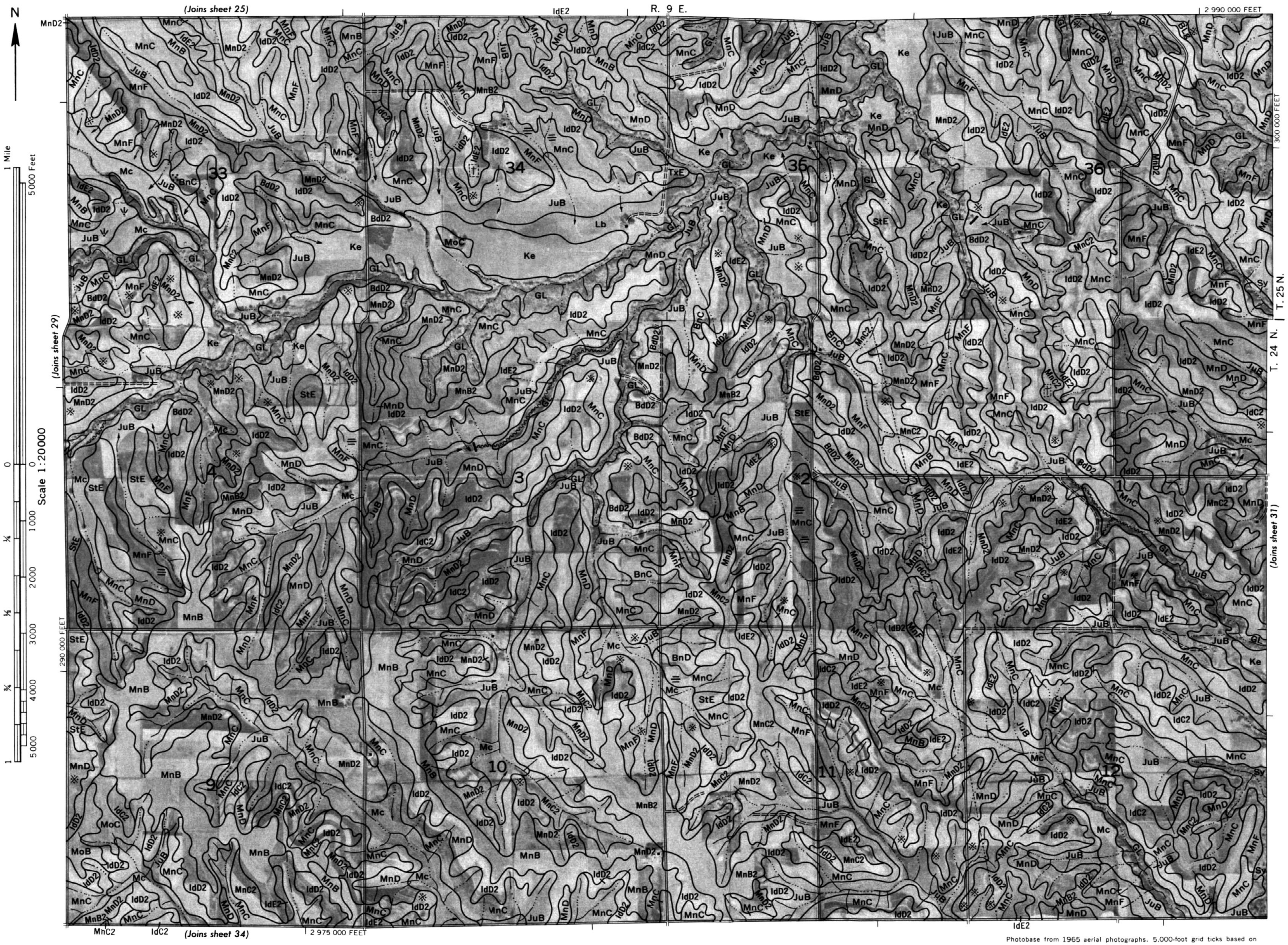
THURSTON COUNTY, NEBRASKA NO. 29

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

30

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 30



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 30

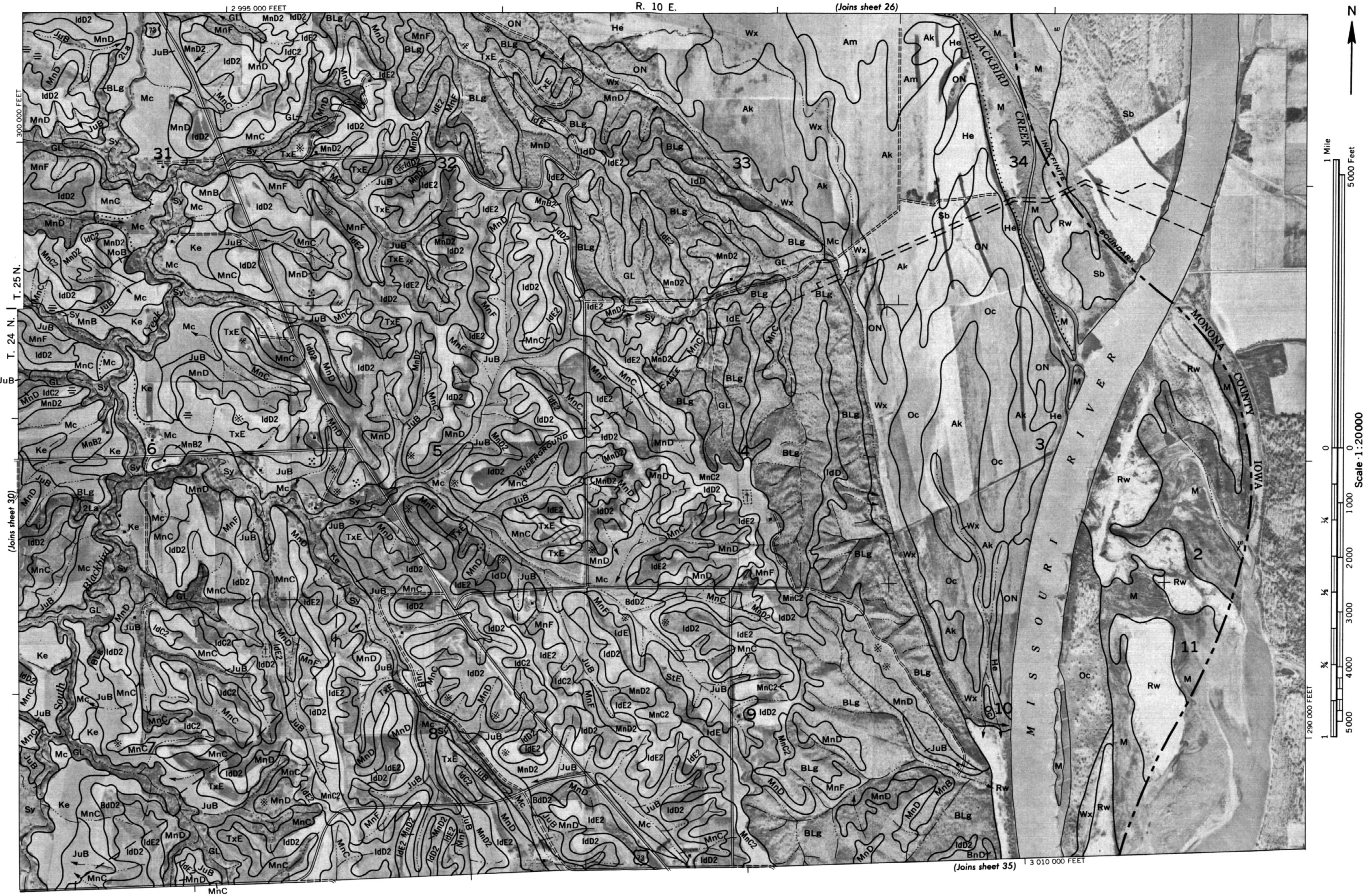
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 31



Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone, 1927 North American datum.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 32

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 32

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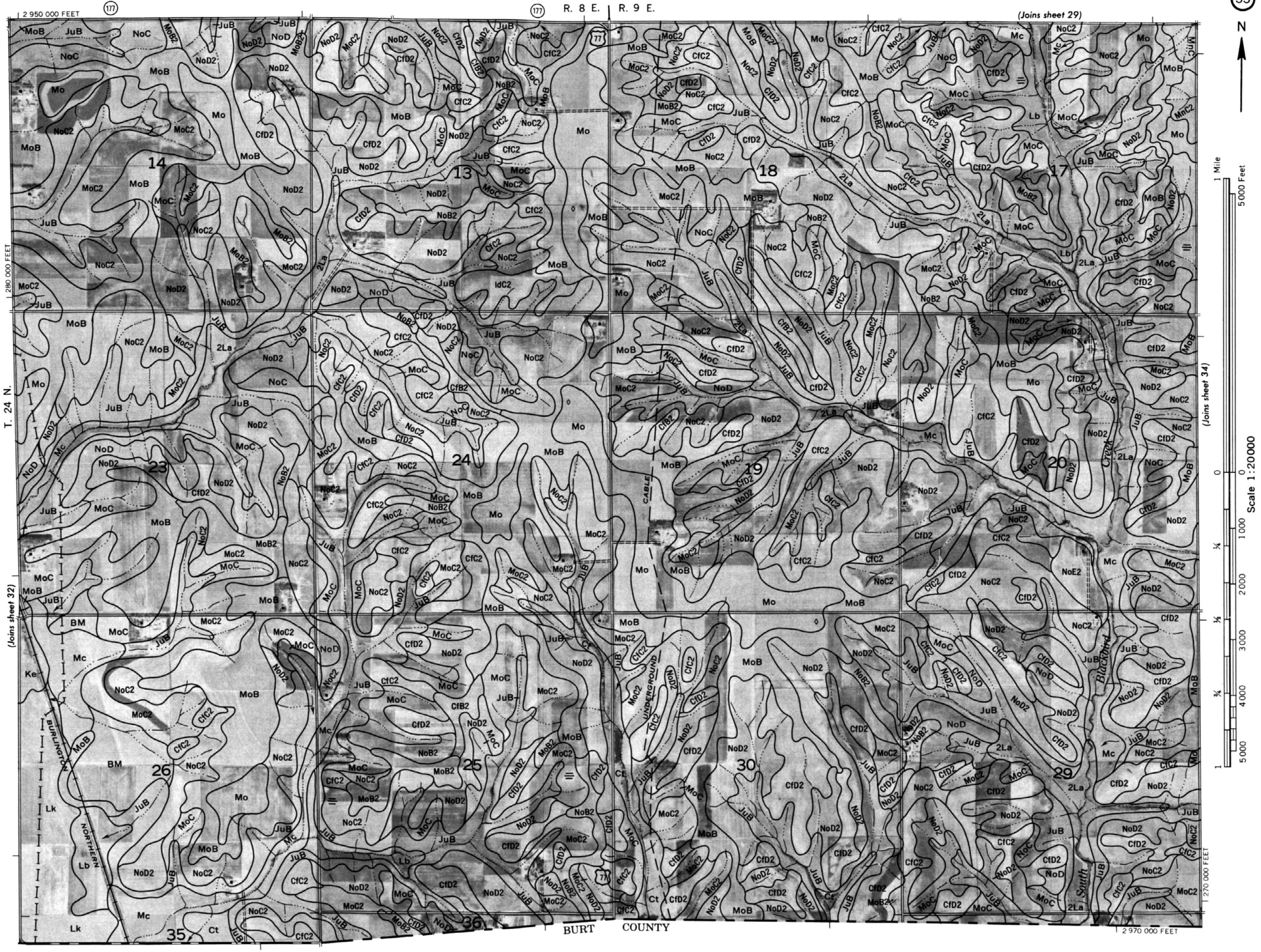
Land division corners are approximately positioned on this map.



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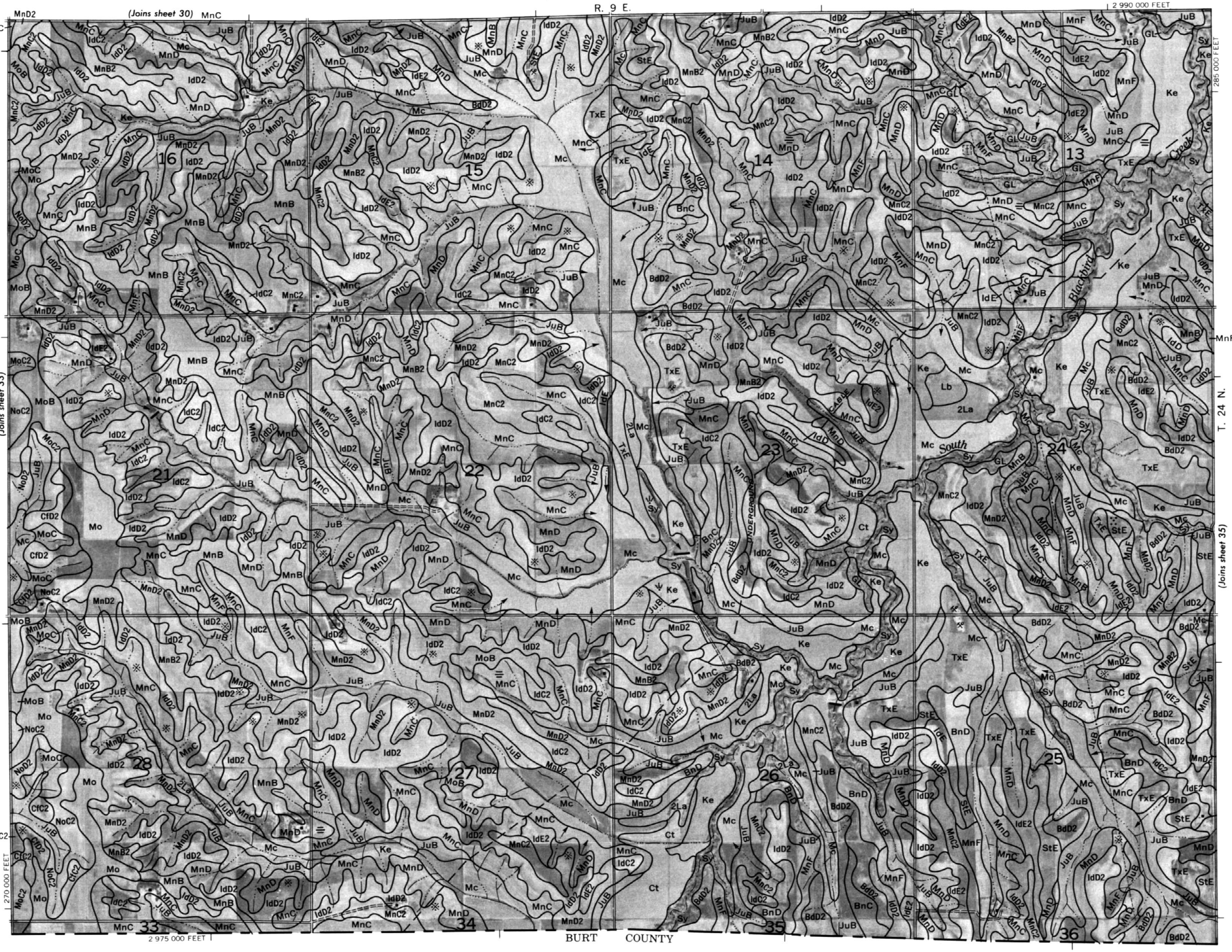
Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 33

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

(34)

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 34



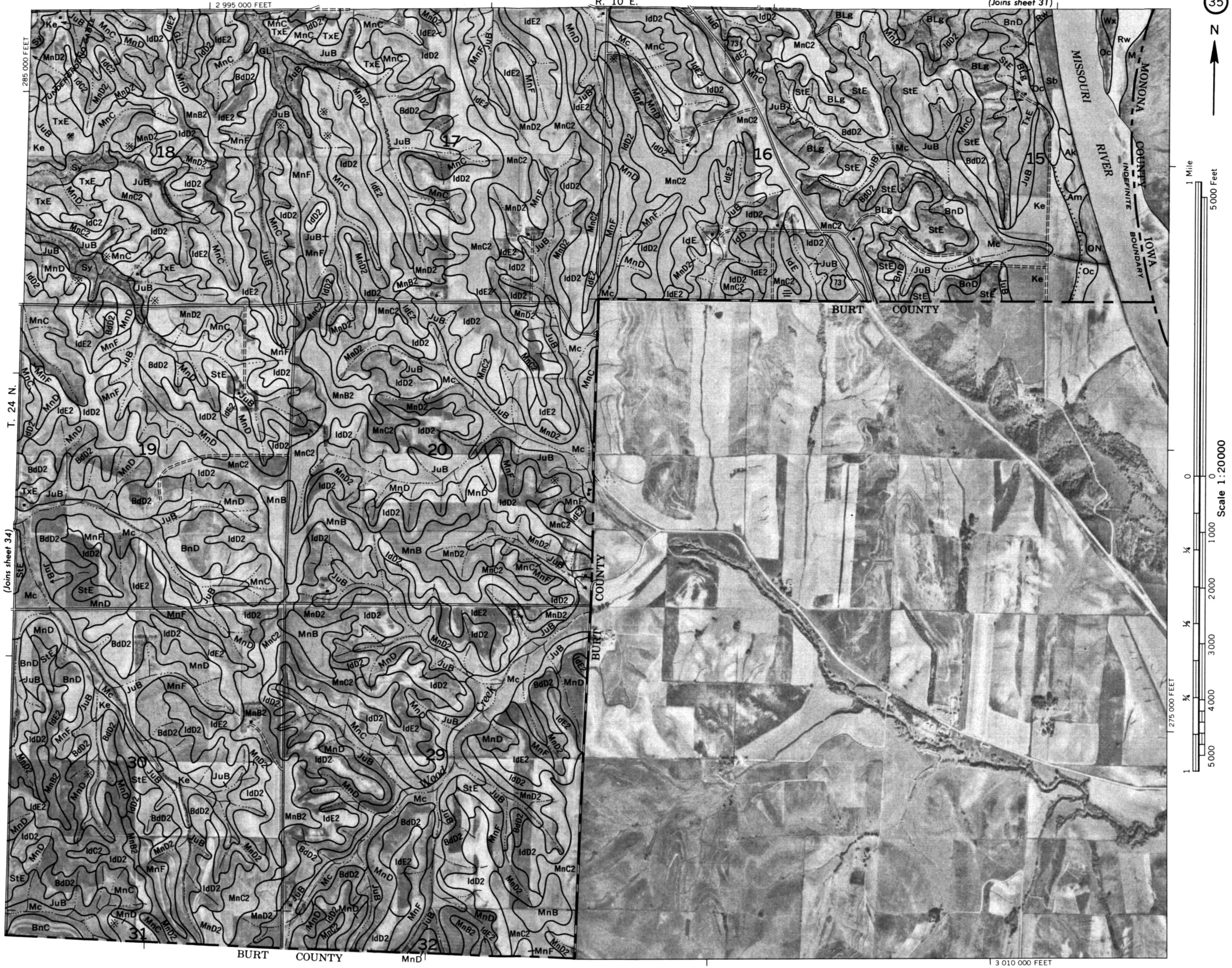
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.

THURSTON COUNTY, NEBRASKA NO. 34

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, the United States Department of the Interior, Bureau of Indian Affairs, and the University of Nebraska, Conservation and Survey Division.

Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA — SHEET NUMBER 35



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Land division corners are approximately positioned on this map.

THURSTON COUNTY, NEBRASKA NO. 35

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Nebraska plane coordinate system, north zone. 1927 North American datum.